Not to be cited without
permission of the authors[1]

Canadian Atlantic Fisheries
Scientific Advisory Committee

CAFSAC Research Document 91/44

Ne pas citer sans
autorisation des auteurs[1]

Comité scientifique consultatif des pêches
canadiennes dans l'Atlantique

CSCPCA Document de recherche 91/44

Assessment of 4VsW Cod in 1990

by

L.P. Fanning and W.J. MacEachern

Marine Fish Division
Bedford Institute of Oceanography
P.O. Box 1006, Dartmouth
Nova Scotia, B2Y 4A2

[1] This series documents the scientific basis for fisheries management advice in Atlantic Canada. As such, it addresses the issues of the day in the time frames required, and the Research Documents it contains are not intended as definitive statements on the subjects addressed but rather as progress reports on ongoing investigations.

Research Documents are produced in the official language in which they are provided to the Secretariat by the author(s).

[1] Cette série documente les bases scientifiques des conseils de gestion des pêches sur la côte atlantique du Canada. Comme telle, elle couvre les problèmes actuels selon les échéanciers voulus et les Documents de recherche qu'elle contient ne doivent pas être considérés comme des énoncés finals sur les sujets traités mais plutôt comme des rapports d'étape sur les études en cours.

Les Documents de recherche sont publiés dans la langue officielle utilisée par les auteur(s) dans le manuscrit envoyé au secrétariat.

Abstract

The 1990 fishery for 4VsW cod took 34,334 t, a shortfall of almost 900 t from the TAC and 2400 t less than in 1989. The proportion of the catch taken in Subdiv. 4Vs declined from 87% in 1988 to 77% perhaps indicating a return to the more equal division of catches seen prior to the mid-1980's.

The catch at age in the 1st quarter indicated a large amount of slow-growing fish from the 4TVn stock were being caught in 4Vs. The catch at age and the total catch for both stocks were adjusted by 7600 t to more accurately reflect the removals from each biological unit. This was not to suggest a problem with misreporting, but rather a more extensive migration by the 4TVn stock out of the Gulf of St. Lawrence.

The SPA was calibrated using both July and March RV indices in ADAPT. However, the calibration results were not used as the basis of the advice because the retrospective trend noted in previous assessments had become too severe to accept the results of the SPA as indicative of the stock size.

A biological update of the resource status was based on RV and commercial C/E trends and the relative sizes of the 1986 and 1987 yearclasses. The indices were consistent in indicating that the stock size had declined from the mid-1980's but was still at or above the mean since 1971. The 1986 yearclass is above average in size and the 1987 yearclass is comparable to the largest yearclasses previously seen. As a result CAFSAC advised that continuing the current multiyear plan at 35200 t would not be detrimental to the longterm health of the stock.

Résumé

En 1990, les prises de morue de 4VsW se sont établies à 34 334 t, soit 900 t de moins que le TPA et 2 400 t de moins qu'en 1989. La proportion des captures provenant de la subdivision 4Vs, qui était de 87 % en 1987, est passée à 77 %, ce qui pourrait être le signe d'un retour à la division plus équitable des prises qui existait avant le milieu des années 1980.

Les données sur les prises selon l'âge du premier trimestre révélaient la présence d'une grande quantité de poissons à croissance lente provenant du stock de 4TVn parmi les captures réalisées dans 4Vs. On a ajusté de 7 600 t les prises selon l'âge et les prises totales des deux stocks, de manière à ce qu'elles reflètent plus précisément les retraits provenant de chaque unité biologique. Cette correction a été apportée non à cause d'un problème de fausses déclarations, mais plutôt en raison de migrations plus étendues du stock de 4TVn hors du golfe du Saint-Laurent.

L'ASP a été étalonnée au moyen des données des campagnes d'évaluation de juillet et mars, en suivant la méthode ADAPT. Toutefois, on n'a pas tenu compte des résultats ainsi obtenus dans la formulation des avis, parce que l'aspect rétrospectif des données, constaté dans les évaluations antérieures, était trop important pour que l'on puisse considérer les résultats de l'ASP comme représentatifs de la grosseur des stocks.

On a fait le point sur la situation biologique des stocks en se fondant sur les campagnes d'evaluation, sur les tendances des prises et de l'effort ainsi que sur la grosseur relative des classes d'âge de 1986 et de 1987. Tous les indices ont confirmé que l'abondance des stocks a diminué depuis le milieu des années 1980, mais qu'elle reste égale ou supérieure à la moyenne depuis 1971. Du point de vue de la grosseur des classes d'âge, celle de 1986 est supérieure à la moyenne et celle de 1987 est comparable à la plus forte classe d'âge ayant existé antérieurement. Par conséquent, le CSCPCA est d'avis qu'on ne nuira pas à la bonne santé du stock à long terme en maintenant à 35 200 t le plan pluriannuel actuel.

Description of the fishery

Catches of 4VsW cod (Table 1; Figure 1) ranged from 40,000 t to 80,000 t in the years 1958 to 1974 and then declined rapidly to a low of 10,000 t in 1977. Subsequent to extension of jurisdiction the catches quickly climbed again and were at or above 50,000 t from 1980 to 1986. Under quota restrictions, the TAC's have been reduced and consequently the catches have declined in recent years to 34,334 t in 1990. Since 1977 the foreign catch has only exceeded 1000 t once and in 1990 was less than 200 t, primarily bycatch in the silver hake fishery.

The total catches (Table 2) and Canadian catches (Table 3) from 1964 to the present, based on NAFO data, are broken down by gear type and Division. Prior to 1980, the total catch was nearly equally split between Subdiv. 4Vs and Div. 4W however, since 1980 the percentage of the catch coming from Subdiv. 4Vs climbed from 60% to 87% in 1988 (Figure 2). The percentage has declined for the last two years and was 77% in 1990, the lowest since 1983. The proportion of the catch taken by each gear type (Figure 3) is essentially unchanged from 1989 with over 70% of the catch taken by otter trawls, 25% taken by longline and handline and the remainder taken primarily by seines and gillnets. The initial allocations to gears (Table 4), made in January, were adjusted during the year. The catches were close to the final allocations for all gears except the FG>45' which was 1250 t over their allocation and the vessels >100' which were 660 t short of their final allocation (1400 t short of their initial allocation).

Catch and weight at age

The 1990 catch at age was constructed by half-year using five separate keys (Table 5), mobile gears (trawlers and seines) for Quarter 1, Quarter 2 and Quarters 3+4, and fixed gears (longline and handline) for Quarters 1+2 and Quarters 3+4. The parameters of the length/weight relationships were estimated from the 1990 March and July RV surveys and applied to the keys for the appropriate time periods (Table 5). The keyed catch accounted for over 98% of the total catch and was pro-rated to the total. The catches at age by key (Table 6) were summed and appended to the catch at age for the years 1971-89 (half-year in Table 7; full year in Table 8) reconstructed by MacEachern and Fanning (1990). The full year catch at age estimated for 1990 (Figure 4) was in close agreement with that projected from the previous assessment (Fanning and MacEachern, 1990) except for the presence of large numbers at ages 9 and 10 which had not been projected.

Examination of the age compositions resulting from each key and for each half year (Table 6) showed that the mobile gear catch at age for the 1st Quarter (Q1-OTB), which accounted for over half the total catch in numbers, had substantially higher proportions of fish at ages 8+ than the other keys. Inspection of the mean weights at age for each key indicated that the Q1-OTB key also estimated mean weights at age substantially below any of the other keys and which were inconsistent with other years. The Q1-OTB samples were used to construct keys broken down by month (Jan, Feb, Mar) and unit area (4Vb, 4Vc). Inspection of the individual month by unit area keys (2 examples are in Table 9) revealed distinct bimodality in the length composition of several age groups, particularly ages 6-10, indicating that a mixture of populations with different growth rates was present in the 1st quarter.

The mean size at age in southern Gulf (4TVn) cod is substantially smaller than in 4VsW cod and they are known to migrate into 4Vn in the winter to the degree that catches from the 4Vn (Jan.-Apr.) fishery are considered part of the 4TVn spawning group for management purposes. There have also been industry reports in the past that indicate parts of the 4TVn migration may extend southward into 4Vs, however, as this usually involves small quantities of catch, the impact has been assumed negligible. In the period 1977-89 the Q1-OTB catch in 4VsW has ranged from 5% to 24% of the total catch (Figure 5). However in the most recent years, the Q1-OTB catch accounted for over 15,000 t out of less than 35,000 t (45%) in 1990, and the 1991 quota reports indicate that the Q1-OTB catch was

14,500 t (41%) of the 35,200 t TAC. The observed mobile gear catches in 4V, from the International Observer Program (IOP), where cod was the main species, were aggregated to 10' squares for the first quarters of 1990 and 1991 (Figure 6). The catches on the maps total 4900 t in 1990 (32% of 1st quarter) and 5500 t in 1991 (36%). A significant concentration of catch has come from the area straddling the 4Vn-4Vs boundary, consistent with a continuous aggregation of fish across the line. The aggregation was probably composed of fish from both 4TVn and 4VsW and so it is likely that 4TVn fish were abundant in the catch in 4VsW.

Given that a mixture of stocks was present in the catch, it was necessary to determine the separate age composition and total catch from each stock (4TVn and 4VsW). To estimate the catch at age from each stock in the Q1-OTB catch, the length ranges and modes at age, from uncontaminated samples, were plotted on the table of percent at age and length based on the Q1-OTB samples from 4VsW (Table 10). The samples from the 4Vn winter fishery were used to determine the length ranges and modes at age for the 4TVn stock. The 1st Half 4VsW longline samples were used to determine the length ranges and modes at age for 4VsW. They were unlikely to be contaminated by 4TVn fish since the longliners fished throughout 4VsW and primarily in the 2nd quarter. The lengths corresponding to visible separations in the month by unit area keys described above were noted as well. Based on these indicators a cut-off length was selected for each age (indicated by the stepped line on Table 10) and the length composition at age was partitioned between 4TVn and 4VsW. After the key was partitioned the length composition (Table 11), age composition, mean length and weight at age, catch at age and total catch (Tables 12 and 13) were calculated for each stock. The 4VsW catch at age, after culling out the component attributed to 4TVn, had significant reductions in the numbers of ages 6 to 10 although there was little change in the younger ages (Table 14, Figure 7) The partitioned catch at age indicated that 7876 t (51%) of the total Q1-OTB catch was from 4VsW and 7627 t was from 4TVn. Consequently, the total catch from the 4VsW cod stock was only 26,707 t rather than the 34,334 t reported. This is not an indication of misreporting, but rather migration by the 4TVn fish to an area south of the 4Vn-4Vs boundary.

The commercial mean weights at age (Table 15) in 1990 were lower than in 1989 for all but 3 ages if the unculled Q1-OTB key was included. The mean weights at age after culling Q1-OTB key were generally higher than in 1989 at all but the oldest ages (ages 14-16). The commercial mean weights at age have increased slightly over the last 3 years for most ages but are still low relative to the years 1978-84.

Commercial catch rates

As a result of research recommendations made last year the commercial C/E was re-examined in considerable detail. The data for the years 1985-1990 were extracted from the Interzonal (ZIFF) database and aggregated into the same the gear/area/month categories previously defined by Sinclair and Smith (1987). In the process 2 selection errors affecting different years were identified. In the past two years (1988-89) the catch and effort data had been selected regardless of main species in the catch. As a consequence the catch rates were artificially deflated by effort that was actually directed on another species. In the years 1985-1987 the catch and effort data had been selected where main species was cod regardless of whether effort was greater than 0. This artificially inflated the C/E by including catch with no effort. After both these problems were corrected a new catch rate series was calculated however it was apparent that there were still problems, particularly with the 1985 data. The effort data from Newfoundland vessels in 1985 appeared to be 1-2 orders of magnitude too large. The C/E was also recalculated based on NAFO data for all available years (1968-88) with Interzonal data being used only in 1989-90. The NAFO data did not contain the erroneous data for Newfoundland OTB in 1985 that was observed in the Interzonal data. The C/E standardization was done using the STSC APL version of STANDARD (Anon. 1986) and the results are in Table 16 and Figure 8. Throughout the 1980's the C/E remained higher than the 1970's and relatively stable, with

the exception of 1985-86 which were the highest observed.

The Canadian OTB (TC 4-5) catch rates from the IOP were calculated for the years 1982-1990 (Table 17 and Figure 8). The observed catch has varied between 7% and 17% of the total OTB catch during 1982-89, however, in 1990 the IOP observed 34% of the OTB catch. When standardized to the same standards, the C/E based on the IOP was significantly higher than that based on the commercial statistics in 1984-89 but nearly equal in 1982, 83 and 90. A possible explanation for this pattern stems from the fact that the sudden divergence of the two C/E series in 1984 coincides with the introduction of Enterprise Allocations for the offshore industry. This change in the management regime enabled the offshore companies to manage their own quota's, and the companies (primarily National Sea Products) introduced trip limits and multi-species trips to meet production needs. Under these management measures, because the IOP data defines main species on a set-by-set basis, while the commercial statistics uses a trip (or sub-trip) to determine main species, it was expected that the IOP C/E would be higher in general than the commercial C/E as effort directed on other species was excluded. The convergence of the two series in 1990 was consistent with anecdotal reports that the NatSea vessels had returned to the more traditional pattern of fishing, i.e. cod-directed trips, in an effort to reduce costs.

While the above explanation may account for the differences in the two C/E series, the fact that the two catch rate series are showing different trends, and that the potential effects of different aggregation levels (i.e. set-by-set compared to trip-by-trip) have not been determined, prevented the use of the commercial or IOP C/E as a calibration index for ADAPT. A research recommendation was made by the CAFSAC Groundfish subcommittee to investigate the effect of data aggregation on the C/E and that the discrepancy between NAFO and ZIF files for the 1985 Newfoundland data be resolved.

Research vessel surveys

The July stratified random trawl survey of 4VsW has been conducted annually since 1970, however the 1970 estimates of abundance are not used in the assessment of this stock because of variations in gear and survey protocol. In addition, the survey estimates for 1970 were deemed inconsistent with the SPA estimates in previous assessments. The research vessel conducting the survey was changed in 1982 and 1983 due to the retirement of the A.T. Cameron, the temporary use of the Lady Hammond (in 1982) and the advent of the Alfred Needler in 1983. The catches from the A.T. Cameron and the Lady Hammond were adjusted by a conversion factor of 0.8 (Fanning, 1985) to account for the change in vessel. Because of differences in age composition, the stratified estimates of mean catch per tow (Table 18) and coefficients of variation (Table 19) were calculated for 4Vs and 4W separately, and combined by weighting by strata areas.

A second survey has been conducted in March from 1979 to 1991 with the exception of 1985. The same conversion factor was applied to the March surveys for the years 1979-83 when the Lady Hammond was the survey vessel. The estimation of abundance from the March survey has been complicated by missing strata due to the presence of ice in the survey area. The CAFSAC Groundfish subcommittee had previously recommended that methods of adjusting for the effect of missing strata be investigated, however this has not been completed and the March survey index (Table 20) assumes that missing strata would have been equal to the overall mean of the sampled strata. The CV's associated with the March survey estimates (Table 21) are generally larger than in the July survey, probably reflecting the patchier, more aggregated distribution of fish in the winter.

The July survey mean catch per tow (Figure 9) in recent years, 1987-90, was higher than all years prior to 1982 except for 1973, but well below the peak of 1982-84. The general trend in the March surveys was similar although 1986 and 1990 seemed to be extremely high and low, respectively, relative to the July estimates.

The July survey mean catch per tow for ages 4+ in 1990 is near the mean for the entire series, and well below the peak levels in 1982-85 (Figure 10). The March survey estimate for ages 4+ was very low in 1990 however, in 1991 the estimate, which includes the strong 1987 yearclass, is comparable to the early 1980's.

Both surveys series have indicated that the 1986 yearclass is above average and the 1987 yearclass is comparable to the very large yearclasses of 1979 and 1980. The 1987 yearclass has constituted 44% to 49% of the mean catch per tow (in numbers) in 4 of the 5 surveys available for 1989 to 1991, and it was 30% of the total numbers in the fifth survey (July 1989).

Estimation of parameters

The half-year ADAPT formulation used in the previous assessment was updated with the new catch at age and survey indices. When the unculled catch at age was used, the fully recruited F in 1990 was estimated at 0.91, well above the F of 0.4 projected for a catch of 35,000 t. in the last assessment. The same formulation, when the culled catch at age was used, estimated the fully recruited F to be 0.56, however it must be recalled that this corresponds to a 1990 catch of only 26,700 t. Estimates of population size using several alternative formulations, such as full year SPA or including the age 3 numbers in the estimation, were investigated (Table 22). When the 4T-culled catch at age was used (Runs 3-6) the mean fully recruited F's ranged from 0.5 to 0.6. Runs 5 and 6 included age 3 in the calibration to get a direct estimate of the 1987 yearclass. The results of Run 6 are given in Table 23 and Figures 11, 12 and 13 based on the following formulation:

Parameters:

Yearclass estimates -- $N_{i,1990}$, i=3 to 9

Calibration coefficients -- $K_{1,i}$, i=3 to 9 for July RV

$K_{2,i}$, i=3 to 9 for March RV

Structure Imposed:

Error in catch assumed negligible

Partial recruitment fixed for ages 1, 2, and 10+

F on oldest age (16) set to weighted mean F from 7 to 9

No intercept was fitted

M=0.2

Input:

$C_{i,t}$, i=1 to 16; t=1971 to 1990 - Full year catch at age

$J_{i,t}$, i=3 to 9; t=1971 to 1990 - July RV index

$M_{i,t}$, i=3 to 9; t=1979 to 1990 - March RV index (excluding 1985)

Objective function: Minimize

$$\sum_{i}\sum_{c}(\ln J_{i,c} - K_{1,i}\times N_{i,c})^2 + \sum_{i}\sum_{c}(\ln M_{i,c} - K_{2,i}\times N_{i,c})^2$$

3 July RV residuals given 0 weight (1974 age 5; 1975 age 6; 1976 age 9)

Summary:

Number of observations 137 July RV (140-3)
77 March RV

Number of parameters 21

Retrospective Analysis

All the ADAPT formulations investigated continue to show the retrospective pattern that has been of concern in this assessment for the last few years. Using the same formulation as last year (described above) and the 4T-culled catch at age in 1990, the ADAPT run indicates that F in 1989 was 0.47 rather than 0.37 as estimated last year. Retrospective F's (Figure 14) from a full year SPA formulation (Run 4) indicate that, not only do the F's in a given year increase as an additional years of data are added, but that the magnitude of the increase has been getting larger since 1987. The lines in Figure 14 connect the estimates of mean fully recruited F in a given year (labelled as 'Fishing Year') when additional years are added to the input data. The retrospective trends have become too strong to use the SPA as a means of determining population abundance and consequently, it is not possible to accept the SPA results as the basis of the assessment of this stock.

Prognosis

In the absence of an acceptable SPA the advice for this stock was based on the trends indicated by the surveys and catch rates. The C/E has declined from the mid-1980's however it is still above the average from 1979 to 1989, a period of high abundance. The July survey indicates that the exploited part of the population (ages 4+) is near the series average while the March survey indicates it is above average in 1991.

The 1987 yearclass was identified in the last assessment as being above average. The addition of new surveys and the 1990 catch at age 3 enhances this view and indicates that the 1987 yearclass is comparable to the largest since 1971. The 1986 yearclass is also above average in size and these two yearclasses will be important in the 1991 and 1992 fisheries.

It was noted that the stock is currently under a multi-year management plan extending to 1993 at 35,200 t per year and has been fished at that level since 1989. The present assessment does not indicate that the resource is being severely reduced by the current catch and so, in spite of the change in the basis of the assessment, a TAC of 35,200 t in 1992 should not be detrimental to the long term health of the resource. The lack of an analytical assessment of this stock makes quantitative projections impossible and so the impact of the present TAC in 1993 or beyond cannot be reliably evaluated.

Recommendations

1). Continue examination and comparison of catch rate indices from Interzonal, Regional and NAFO commercial statistics and the IOP database.

2). Evaluate the impact of 4TVn fish in the winter being caught in 4Vs and examine methods of distinguishing the stock affinity of sampled catches from that part of the fishery.

References

Anon. 1986. CAFSAC Assessment Software Catologue. CAFSAC Res. Doc 86/96.

Fanning L.P. and W.J. MacEachern. 1990. Stock Status of 4VsW cod in 1989 using a Half-year SPA Formulation. CAFSAC Res. Doc 90/88. 52 p.

MacEachern W.J. and L.P. Fanning. 1990. Reconstruction of the 4VsW cod catch at age on a half-year basis (1971-1989). CAFSAC Res. Doc. 90/87. 28 p.

Sinclair A. and S.J. Smith. 1987. Assessment of 4VsW Cod. CAFSAC Res. Doc. 87/72. 62 p.

Table 1. 4VsW cod nominal catches by country and NAFO Divisions.

YEAR	CANADA	FRANCE	PORTUGAL	SPAIN	USSR	OTHERS	TOTAL	SUBDIV. 4Vs	DIV. 4W	TAC
1958	17938	4577	1095	14857	-	124	38591	23790	14801	-
1959	20069	16378	8384	19999	-	1196	66026	47063	18963	-
1960	18389	1018	1720	29391	-	126	50645	27689	22956	-
1961	19697	3252	2321	40884	113	42	66309	34237	32072	-
1962	17579	2645	341	42146	2383	60	65154	26350	38804	-
1963	13144	72	617	44528	9505	307	68173	27566	40607	-
1964	14330	1010	-	39690	7133	1094	63257	25496	37761	-
1965	23104	536	88	39280	7856	122	70986	36713	34273	-
1966	17690	1494	-	43157	5473	711	68525	27177	41348	-
1967	18464	77	102	33934	1068	513	54158	26607	27551	-
1968	24888	225	-	50418	4865	32	80428	48781	31647	-
1969	14188	217	-	32305	2783	672	50165	22316	27849	-
1970	11818	420	296	41926	2521	453	57434	28639	28795	-
1971	17064	4	18	30864	4506	107	52563	24128	28435	-
1972	19987	495	856	28542	4646	7119	61645	36533	25112	-
1973	15929	922	849	30883	2918	2592	54093	23401	30692	60500
1974	10700	35	1464	27384	3097	1061	43741	19611	24130	60000
1975	9939	1867	546	15611	3042	1512	32517	11694	20823	60000
1976	9567	697	-	11090	1018	2035	24407	11553	12854	30000
1977	9890	68	-	-	97	335	10390	2873	7517	7000
1978	24642	437	-	57	218	51	25405	10357	15048	7000
1979	39219	18	-	2	683	108	40030	15393	24637	30000
1980	48821	17	5	5	338	66	49252	31378	17874	45000
1981	53053	-	-	-	630	35	53718	32107	21611	50000
1982	55675	-	-	-	45	34	55754	40110	15644	55600
1983	50898	-	1230	-	190	62	52380	33170	19210	64000
1984	52104	-	303	-	110	29	52546	42578	9968	55000
1985	56553	-	870	-	21	11	57455	48189	9266	55000
1986	51467	-	-	-	28	34	51529	44028	7501	48000
1987	45430	-	-	-	25	48	45503	39755	5748	44000
1988	38215	-	-	-	106	35	38356	33729	4627	38000
1989	36574[1]	-	-	-	168[2]	49[2]	36791	29330	7461	35200
1990	34136[1]	-	-	-	127[2]	71[2]	34334	26340	7994	35200
1991										35200

[1] Preliminary Catch Statistics (ZIFF)

[2] ICP

Table 2. Total catch of 4VsW cod by gear[1] and (Sub)Division from NAFO.

	4Vs					4W					4VsW				
YEAR	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL
1964	25452	42	2	0	25496	32855	708	88	4110	37761	58307	750	90	4110	63257
1965	36607	84	22	0	36713	28931	1416	159	3767	34273	65538	1500	181	3767	70986
1966	27006	143	14	14	27177	36460	1474	38	3376	41348	63466	1617	52	3390	68525
1967	26481	99	27	0	26607	22407	2405	71	2668	27551	48888	2504	98	2668	54158
1968	48715	48	18	0	48781	24686	2970	89	3902	31647	73401	3018	107	3902	80428
1969	22265	43	7	1	22316	21946	3567	13	2323	27849	44211	3610	20	2324	50165
1970	28617	21	1	0	28639	23655	3817	62	1261	28795	52272	3838	63	1261	57434
1971	24088	40	0	0	24128	22006	4819	26	1584	28435	46094	4859	26	1584	52563
1972	33570	595	4	2364	36533	15888	3793	7	5424	25112	49458	4388	11	7788	61645
1973	21654	82	3	1662	23401	25144	3748	20	1780	30692	46798	3830	23	3442	54093
1974	19105	337	0	169	19611	18931	2969	5	2225	24130	38036	3306	5	2394	43741
1975	10522	444	0	728	11694	16336	3185	11	1291	20823	26858	3629	11	2019	32517
1976	10068	68	0	1417	11553	8021	2913	14	1906	12854	18089	2981	14	3323	24407
1977	2819	50	4	0	2873	2305	3487	68	1657	7517	5124	3537	72	1657	10390
1978	10044	294	19	0	10357	8277	4552	839	1380	15048	18321	4846	858	1380	25405
1979	14869	438	86	0	15393	14579	5825	3245	988	24637	29448	6263	3331	988	40030
1980	28941	2116	321	0	31378	6729	6588	3440	1117	17874	35670	8704	3761	1117	49252
1981	27662	4274	171	0	32107	9813	8229	2433	1136	21611	37475	12503	2604	1136	53718
1982	32247	7069	794	0	40110	6431	6655	1943	615	15644	38678	13724	2737	615	55754
1983	28024	4475	671	0	33170	11555	5052	1936	667	19210	39579	9527	2607	667	52380
1984	37576	4123	879	0	42578	3839	3512	2144	473	9968	41415	7635	3023	473	52546
1985	39978	7449	718	44	48189	3768	3386	1229	883	9266	43746	10835	1947	927	57455
1986	35514	8277	237	0	44028	2758	3075	600	1068	7501	38272	11352	837	1068	51529
1987	33157	6276	311	11	39755	1803	2666	538	741	5748	34960	8942	849	752	45503
1988	26964	6097	612	56	33729	1240	2163	382	842	4627	28204	8260	994	898	38356
1989[2]	22563	6324	402	41	29330	3539	2990	323	609	7461	26102	9314	725	650	36791
1990[2]	22272	3840	224	4	26340	2997	4027	532	438	7994	25269	7867	756	442	34334

[1] Gear designations include the following: TRAWLS - Side/stern bottom, side/stern midwater, pair trawls and shrimp trawls; LL - Set/drift longlines, Hand lines, jigs, dory vessel lines; SDN - Scottish, danish and pair seines; MIS - Miscellaneous gears not included above.

[2] Preliminary Interzonal and International Observer Program data.

Table 3. Canadian catch of 4VsW cod by gear[1] and (sub) Division (from NAFO).

	4Vs					4W					4VsW				
YEAR	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL	TRAWLS	LL	SDN	MIS	TOTAL
1964	2056	42	2	-	2100	7324	708	88	4110	12230	9380	750	90	4110	14330
1965	7366	84	22	-	7472	10290	1416	159	3767	15632	17656	1500	181	3767	23104
1966	6374	143	14	-	6531	6614	1472	38	3035	11159	12988	1615	52	3035	17690
1967	6735	99	27	-	6861	6460	2405	71	2667	11603	13195	2504	98	2667	18464
1968	9501	48	18	-	9567	8360	2970	89	3902	15321	17861	3018	107	3902	24888
1969	3540	43	7	-	3590	4695	3567	13	2323	10598	8235	3610	20	2323	14188
1970	3054	21	1	-	3076	3602	3817	62	1261	8742	6656	3838	63	1261	11818
1971	5827	40	-	-	5867	4768	4819	26	1584	11197	10595	4859	26	1584	17064
1972	9856	115	4	-	9975	4732	3793	7	1480	10012	14588	3908	11	1480	19987
1973	6392	82	3	-	6477	4723	3748	20	961	9452	11115	3830	23	961	15929
1974	4644	56	-	-	4700	1335	2969	5	1691	6000	5979	3025	5	1691	10700
1975	1824	63	-	-	1887	3566	3185	11	1290	8052	5390	3248	11	1290	9939
1976	3755	42	-	-	3797	937	2913	14	1906	5770	4692	2955	14	1906	9567
1977	2751	50	4	-	2805	1873	3487	68	1657	7085	4624	3537	72	1657	9890
1978	9561	294	19	-	9874	7997	4552	839	1380	14768	17558	4846	858	1380	24642
1979	14853	438	86	-	15377	13742	5825	3245	988	23842	28637	6263	3331	988	39219
1980	28941	2116	321	-	31378	6298	6588	3440	1117	17443	35239	8704	3761	1117	48821
1981	27662	4274	171	-	32107	9148	8229	2433	1136	20946	36810	12503	2604	1136	53053
1982	32247	7069	794	-	40110	6352	6655	1943	615	15565	38599	13724	2737	615	55675
1983	26817	4475	671	-	31963	11280	5052	1936	667	18935	38097	9527	2607	667	50898
1984	37290	4123	879	-	42292	3683	3512	2144	473	9812	40973	7635	3023	473	52104
1985	39098	7449	718	44	47309	3746	3386	1229	883	9244	42844	10835	1947	927	56553
1986	35482	8277	237	-	43996	2728	3075	600	1068	7471	38210	11352	837	1068	51467
1987	33139	6276	311	11	39737	1748	2666	538	741	5693	34887	8942	849	752	45430
1988	26959	6077	612	56	33704	1124	2163	382	842	4453	28083	8240	994	898	38215
1989[2]	22563	6324	402	41	29330	3322	2990	323	609	7244	25885	9314	725	650	36574
1990[2]	22272	3840	224	4	26340	2799	4027	532	438	7796	25071	7867	756	442	34136

[1] Gear designations include the following:

TRAWLS - Side/stern bottom, side/stern midwater, pair trawls and shrimp trawls; LL - Set/drift longlines, Hand lines, jigs, dory vessel lines; SDN - Scottish, danish and pair seines; MIS - Miscellaneous gears not included above.

[2] Preliminary Interzonal data.

Table 4. Resource management of 4VsW cod - 1990 domestic allocations and catches from quota reports.

Gear Sector	Allocations at Specific Dates						Total Catches to Specific Dates			
	Jan 1	May 15	July 1	Oct 15	Dec 31		May 15	July 1	Oct 15	Dec 31
Vessels >100'	23160	22470	22420	22320	22444		15873	16193	17141	21782
MG 65-100'	625	1148	1198	1298	1152		598	668	769	881
FG 65-100'	520	687	687	687	709		445	435	600	697
MG 45-64'	2835									
Eastern N.S.										
(Jan-Apr)		945	709	709	709		1103	782	661	661
(May-Aug)		945	709	709	709		215	350	1076	923
(Sep-Dec)		945	708	708	708		--	--	197	325
SW N.S. & SW N.B.*										
(Jan-Dec)		--	709	709	709		--	565	695	683
MG <45'	1215									
Eastern N.S.										
(Jan-Apr)		405	304	304	304		421	309	311	311
(May-Aug)		810	304	304	304		151	230	450	437
(Sep-Dec)		--	304	304	304		--	--	68	72
SW N.S. & SW N.B.*										
(Jan-Dec)		--	303	303	303		--	181	238	197
FG 45-64'	1985									
(Jan-Mar)		250	250	250	250		83	87	100	101
(Apr-Aug)		1400	1400	1400	1400		361	581	671	664
(Sep-Dec)		335	335	335	335		--	--	197	280
FG <45'	4860									
Eastern N.S.										
(Jan-Mar)		185	157	157	157		350	373	384	391
(Apr-Aug)		3510	2983	2983	2983		375	751	3250	3757
(Sep-Dec)		1165	990	990	990		--	--	561	1730
SW N.S. & SW N.B.*										
(Jan-Dec)		--	730	730	730		--	121	296	233
Totals	35200				35200	% of TAC	56.7	61.4	78.6	96.9

* Prior to June 1, <65' gear sectors were given 3 partial year allocations. As of June 1, Southwestern Nova Scotia and Southwestern New Brunswick vessels were given a seperate allocation versus Eastern Nova Scotian vessels within these gear sectors and time frames. Catches made prior to that time were re-assigned accordingly.

Table 5. Data used to calculate 4VsW cod commercial catch at age.

Year	Half	Key	Gear	Period	Length/weight coefficients a	b	Source	Lengths	Aged	Catch
1990	1	1	OTB, PTB, SNU	Q1	.0054	3.1062	March 4Vs	11753	1218	15532
		2	OTB, PTB, SNU	Q2	.0096	2.9863	July 4VsW	3134	285	3564
		3	LL, LHP	H1	.0096	2.9863	July 4VsW	6948	923	2833
	2	1	OTB, PTB, SNU	H2	.1347	2.2864	July 4Vs	4780	489	6730
		2	LL, LHP	H2	.0096	2.9863	July 4VsW	4939	586	5034

Table 6. 4VsW cod catch at age ('000) by key for each half of 1990.

First half

Age	OTB, PTB, SNU Q1	OTB, PTB, SNU Q2	LL, LHP H1	Total
1	0	0	0	0
2	0	0	0	0
3	14	5	2	21
4	464	64	55	583
5	1583	194	181	1958
6	2252	218	180	2650
7	1433	184	98	1715
8	2054	344	147	2545
9	1074	180	83	1337
10	1383	135	85	1603
11	183	44	41	268
12	60	24	20	104
13	19	6	17	42
14	1	1	4	6
15	3	1	4	8
16	5	1	3	9
Total	10528	1401	920	12849

Second half

Age	OTB, PTB, SNU H2	LL, LHP H2	Total
1	0	0	0
2	0	0	0
3	277	24	301
4	1514	404	1918
5	1398	715	2113
6	669	379	1048
7	369	178	547
8	303	376	679
9	183	148	331
10	165	118	283
11	36	26	62
12	22	11	33
13	8	5	13
14	8	3	11
15	5	2	7
16	2	2	4
Total	4959	2391	7350

Table 7. 4VsW cod commercial catch at age by half years.

	71.0	71.5	72.0	72.5	73.0	73.5	74.0	74.5	75.0	75.5	76.0	76.5	77.0	77.5	78.0	78.5	79.0	79.5	80.0	80.5
1	1472	512	710	1336	623	595	787	486	945	593	363	150	0	1	8	26	3	9	15	16
2	9514	3310	6651	9214	5231	4990	4518	2803	5267	3304	2029	837	4	19	20	74	10	83	15	77
3	7133	2510	5458	6343	4196	3805	8011	5313	4543	2859	1922	938	91	441	96	1072	545	1217	341	1424
4	3746	1379	8390	3599	3144	2659	6906	4789	1908	1255	2416	2291	239	990	834	3244	3586	2973	1176	3697
5	4811	1801	5343	2041	5264	4370	4033	2821	2858	1930	1943	1957	516	1075	1473	3344	5198	4327	3201	3736
6	3725	1403	4906	1621	1822	1502	1323	924	1967	1330	1038	1047	483	362	1011	1571	2465	2591	3669	2508
7	2484	935	2486	822	1846	1524	393	276	1755	1188	637	650	297	193	372	395	612	598	1692	1358
8	1426	537	1413	467	2593	2139	592	416	371	252	222	225	136	63	127	120	153	224	748	373
9	511	193	261	86	923	761	115	81	296	201	67	69	111	7	66	41	30	46	193	120
10	267	100	350	116	213	176	90	63	409	277	26	27	29	4	42	33	4	19	50	42
11	116	43	51	17	302	249	8	5	103	69	6	6	39	3	18	13	1	9	30	20
12	126	47	6	2	4	4	1	1	73	50	23	24	41	3	14	13	1	3	23	3
13	113	43	27	9	12	9	0	0	24	17	0	0	11	0	15	13	1	2	2	2
14	58	22	0	0	12	9	0	0	4	2	2	2	3	0	5	5	0	0	0	0
15	29	11	2	1	10	8	0	0	4	2	0	0	2	0	1	0	0	0	1	0
16	38	14	5	2	26	21	0	0	11	8	1	1	6	0	2	0	0	0	7	0
3+	24583	9038	28698	15126	20367	17236	21472	14689	14326	9440	8303	7237	2004	3141	4076	9864	12596	12009	11133	13283
4+	17450	6528	23240	8783	16171	13431	13461	9376	9783	6581	6381	6299	1913	2700	3980	8792	12051	10792	10792	11859
5+	13704	5149	14850	5184	13027	10772	6555	4587	7875	5326	3965	4008	1674	1710	3146	5548	8465	7819	9616	8162
6+	8893	3348	9507	3143	7763	6402	2522	1766	5017	3396	2022	2051	1158	635	1673	2204	3267	3492	6415	4426

	81.0	81.5	82.0	82.5	83.0	83.5	84.0	84.5	85.0	85.5	86.0	86.5	87.0	87.5	88.0	88.5	89.0	89.5	90.0	90.5
1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	41	217	1	137	2	4	0	1	0	4	0	3	0	0	0	8	7	0	0	0
3	882	2318	705	1768	1898	1609	71	359	68	88	74	50	34	4	22	163	120	551	21	311
4	4239	4897	3582	4085	5007	3672	2527	3251	968	1285	1675	2535	411	466	234	1278	488	2056	590	1979
5	3406	3875	7150	2973	4320	3164	3977	5124	3996	4155	3266	4374	2863	2831	834	1565	1439	2672	1981	2181
6	2496	2155	2733	948	4210	2068	3328	2350	4495	3028	5405	3816	2574	3311	1880	2651	1495	1839	2682	1082
7	1533	1424	1976	592	1097	808	2498	1331	3005	1279	2281	1308	3379	2670	2487	1588	2404	1265	1736	565
8	706	715	884	431	653	359	698	552	1692	738	978	593	1514	1219	1897	1398	994	802	2576	701
9	213	184	437	242	362	263	316	228	795	268	719	404	579	526	1162	569	1289	729	1353	342
10	55	80	158	160	83	141	110	180	278	174	276	171	319	285	383	243	372	218	1622	292
11	38	31	94	59	54	95	41	112	183	101	178	107	102	131	191	69	138	113	271	64
12	13	19	37	28	22	30	17	46	123	50	50	55	54	77	85	68	104	52	105	34
13	8	14	30	24	10	14	13	21	26	42	38	28	30	31	47	17	16	13	43	13
14	1	1	9	46	11	4	6	11	12	8	7	4	4	7	7	2	6	9	6	11
15	2	3	13	6	4	2	7	1	6	11	13	6	8	6	8	2	31	27	8	7
16	2	0	3	16	2	9	0	5	13	2	13	5	6	6	6	5	2	33	9	4
3+	13594	15716	17811	11378	17733	12238	13609	13571	15660	11229	14973	13456	11877	11570	9243	9618	8898	10379	13003	7586
4+	12712	13398	17106	9610	15835	10629	13538	13212	15592	11141	14899	13406	11843	11566	9221	9455	8778	9828	12982	7275
5+	8473	8501	13524	5525	10828	6957	11011	9961	14624	9856	13224	10871	11432	11100	8987	8177	8290	7772	12392	5296
6+	5067	4626	6374	2552	6508	3793	7034	4837	10628	5701	9958	6497	8569	8269	8153	6612	6851	5100	10411	3115

Table 8. 4VsW cod commercial full year catch at age.

	71	72	73	74	75	76	77	78	79	80	81	82	83
1	1984	2046	1218	1273	1538	513	1	34	12	31	3	3	0
2	12824	15865	10221	7321	8571	2866	23	94	93	92	258	138	6
3	9643	11801	8001	13324	7402	2860	532	1168	1762	1765	3200	2473	3507
4	5125	11989	5803	11695	3163	4707	1229	4078	6559	4873	9136	7667	8679
5	6612	7384	9634	6854	4798	3900	1591	4817	9525	6937	7291	10123	7484
6	5128	6527	3324	2247	3297	2085	845	2582	5056	6177	4651	3681	6278
7	3419	3308	3370	669	2943	1287	490	767	1210	3050	2957	2568	1905
8	1963	1880	4732	1008	623	447	199	247	377	1121	1421	1315	1012
9	704	347	1684	196	497	136	118	107	76	313	397	679	625
10	367	466	389	153	686	53	33	75	23	92	135	318	224
11	159	68	551	13	172	12	42	31	10	50	69	153	149
12	173	8	8	2	123	47	44	27	4	26	32	65	52
13	156	36	21	0	41	0	11	28	3	4	22	54	24
14	80	0	21	0	6	4	3	10	0	0	2	55	15
15	40	3	18	0	6	0	2	1	0	1	5	19	6
16	52	7	47	0	19	2	6	2	0	7	2	19	11
3+	33621	43824	37603	36161	23766	15540	5145	13940	24605	24416	29310	29189	29971
4+	23978	32023	29602	22837	16364	12680	4613	12772	22843	22651	26110	26716	26464
5+	18853	20034	23799	11142	13201	7973	3384	8694	16284	17778	16974	19049	17785
6+	12241	12650	14165	4288	8413	4073	1793	3877	6759	10841	9693	8926	10301

	84	85	86	87	88	89	90
1	0	0	0	0	0	0	0
2	1	4	3	0	8	7	0
3	430	156	124	38	185	671	332
4	5778	2253	4210	877	1512	2544	2569
5	9101	8151	7640	5694	2399	4111	4162
6	5679	7523	9221	5885	4531	3334	3763
7	3829	4284	3589	6049	4075	3669	2300
8	1250	2430	1571	2733	3295	1796	3276
9	544	1063	1123	1105	1731	2018	1695
10	290	452	447	604	626	590	1914
11	153	284	285	233	260	251	335
12	63	173	105	131	153	156	139
13	34	68	66	61	64	29	56
14	17	20	11	11	9	15	17
15	8	17	19	14	10	58	15
16	5	15	18	12	11	35	13
3+	27180	26889	29429	23447	18861	19277	20586
4+	26750	26733	29305	23409	18676	18606	20254
5+	20972	24480	24095	22532	17164	16062	17685
6+	11871	16329	16455	16838	14765	11951	13523

Table 9. Sample keys highlighting the presence of 4T cod in 4Vs.

AREA: 4VB SPECIES: COD(ATLANTIC) GEAR: OTB-1 OTB-2 PTB DATA: COMMERCIAL START DATE: FEB. 1,1990 END DATE: FEB.28,1990

SEX: COMBINED

PERCENT BY NUMBERS

LGTH GRP	AGE IN YEARS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	LGTH FREQ	EST NO CAUGHT
34.0																	0.00	0.00
37.0																	0.00	0.00
40.0				.70	.35												1.05	1151.70
43.0				3.40	1.13	2.26											6.79	7463.31
46.0					2.48	7.43	2.48		2.48								14.85	16319.77
49.0					3.13	4.40				6.26							18.79	20653.02
52.0						2.96	2.96		5.93	5.93							17.78	19537.43
55.0								1.90	3.80	5.71							11.41	12541.62
58.0						1.74		3.47	1.74	1.74							6.68	9340.65
61.0					.97	.97		1.94	.97	.97							5.82	6397.22
64.0						.71	.71	.71		.71	1.42						4.26	4631.04
67.0								2.45		1.63							4.08	4489.09
70.0								1.84	.46	.92							3.22	3540.71
73.0							.81	.41		.41							1.63	1788.41
76.0								.60	.20								.80	876.13
79.0								.42									.42	456.13
82.0																	0.00	0.00
85.0								.21									.21	228.07
88.0									.21								.21	228.07
91.0																	0.00	0.00
94.0																	0.00	0.00
															TOTAL FREQUENCY		100.00	109892.38

AREA: 4VC SPECIES: COD(ATLANTIC) GEAR: OTB-1 OTB-2 PTB DATA: COMMERCIAL START DATE: JAN. 1,1990 END DATE: JAN.31,1990

SEX: COMBINED

PERCENT BY NUMBERS

LGTH GRP	AGE IN YEARS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	LGTH FREQ	EST NO CAUGHT
37.0																	0.00	0.00
40.0																	0.00	0.00
43.0					.16												8.18	16145.07
46.0				5.83	7.77	1.94	1.94										17.49	34497.97
49.0					10.09	4.28	2.14										17.10	33741.02
52.0					.98	3.49	1.74	1.74	1.74		1.75						15.69	30964.04
55.0					2.25		3.50		3.50								14.00	27624.12
58.0						2.96	1.97	.99	1.97	.99							8.88	17515.12
61.0						1.29	.65	1.94	1.29								5.18	10213.36
64.0						.48	1.43		1.43	.95							4.29	8455.49
67.0						.37	.75	1.49		.75							3.36	6635.56
70.0							.26	1.32	.26	.53		.32					2.37	4675.50
73.0								1.30	.32								1.94	3827.08
76.0								.18	.04								.22	436.17
79.0								.12	.06	.05							.23	456.31
82.0									.20		.10						.30	594.78
85.0								.19		.19	.19						.58	1140.84
88.0									.00		.00	.00					.01	25.98
91.0												.01	.00				.01	23.09
94.0										.13							.13	261.71
97.0										.00	.00						.00	8.66
100.0											.01						.01	17.32
103.0											.01						.01	14.43
106.0												.00	.00		.00		.01	11.55
109.0												.00					.00	2.89
112.0																	0.00	0.00
115.0																	0.00	0.00
118.0																	0.00	0.00
															TOTAL FREQUENCY		100.00	197302.94

Table 10. Size ranges of 4T and 4VsW cod during January to March, 1990.

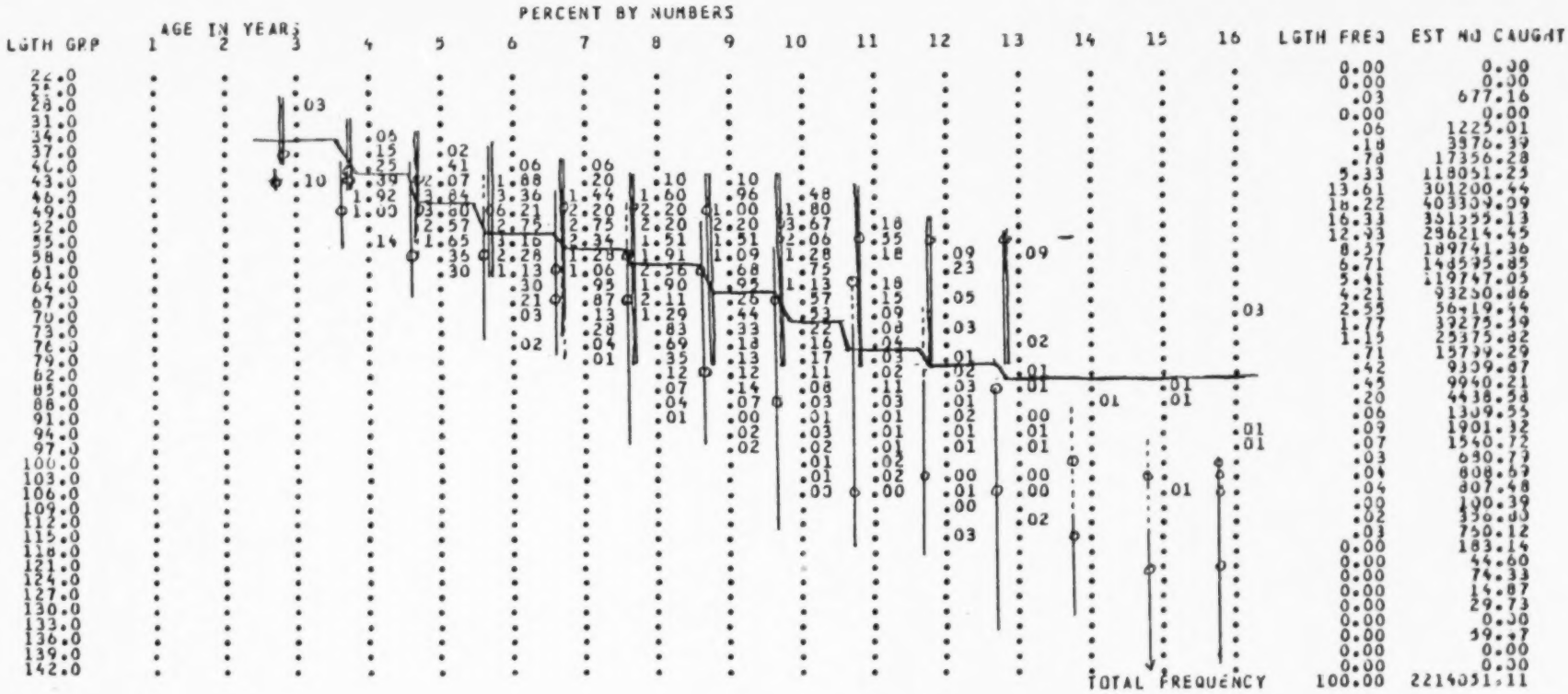

Table 11. Reallocation of observed length frequency from Q1-OTB fishery in 1990 between 4VsW and 4T stocks.

Length Group	Observed Length Freq.	4VsW		4T	
		Proportion	Numbers	Proportion	Numbers
25	0	.000	0	.000	0
28	677	.000	0	1.000	677
31	0	.000	0	.000	0
34	1225	.000	0	1.000	1225
37	3876	.000	0	1.000	3876
40	17356	.000	0	1.000	17356
43	118061	.185	21888	.815	96173
46	301200	.141	42522	.859	258678
49	403309	.264	106309	.736	297000
52	361555	.157	56936	.843	304619
55	286214	.383	109656	.617	176558
58	189741	.458	86891	.542	102850
61	148596	.753	111834	.247	36761
64	119747	.582	69723	.418	50024
67	93261	.818	76244	.182	17017
70	56419	.744	41981	.256	14438
73	39276	.938	36835	.062	2441
76	25376	.948	24052	.052	1324
79	15799	.986	15574	.014	226
82	9310	.975	9077	.025	233
85	9940	1.000	9940	.000	0
88	4439	1.000	4439	.000	0
91	1310	1.000	1310	.000	0
94	1901	1.000	1901	.000	0
97	1541	1.000	1541	.000	0
100	681	1.000	681	.000	0
103	809	1.000	809	.000	0
106	807	1.000	807	.000	0
109	100	1.000	100	.000	0
112	357	1.000	357	.000	0
115	760	1.000	760	.000	0
118	183	1.000	183	.000	0
121	45	.000	0	.000	0
124	74	.000	0	.000	0
127	15	.000	0	.000	0
130	30	.000	0	.000	0
133	0	.000	0	.000	0
136	59	.000	0	.000	0
139	0	.000	0	.000	0

Table 12. Reconstructed age-length key for 4VsW cod after culling 4T cod from the key and length frequencies.

Age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Length Composition	Numbers
43	.0027	.0237													.0264	21888
46		.0511													.0511	42522
49		.0266	.1012												.1278	106309
52			.0684												.0684	56936
55		.0037	.0439	.0841											.1318	109656
58			.0096	.0607	.0341										.1044	86891
61			.0080	.0301	.0282	.0682									.1345	111834
64				.0080	.0253	.0506									.0839	69723
67				.0056	.0232	.0562	.0069								.0919	76244
70				.0008	.0035	.0344	.0117								.0503	41981
73					.0075	.0221	.0088	.0059							.0442	36835
76				.0005	.0011	.0184	.0048	.0043							.0290	24052
79					.0003	.0093	.0035	.0045	.0008						.0184	15574
82						.0032	.0032	.0029	.0005	.0005					.0104	9077
85						.0019	.0037	.0021	.0029	.0008	.0003		.0003		.0120	9940
88						.0011	.0019	.0008	.0008	.0003		.0003	.0003		.0053	4439
91						.0003	.0001	.0003	.0003	.0005	.0001				.0015	1310
94							.0005	.0008	.0003	.0003	.0003			.0003	.0024	1901
97							.0005	.0005	.0003	.0003	.0003			.0003	.0021	1541
100								.0003	.0005						.0008	681
103								.0003	.0005	.0001	.0001				.0010	809
106								.0001	.0001	.0003	.0001		.0003		.0009	807
109										.0001					.0001	100
112											.0005				.0005	357
115										.0008					.0008	760
Age Comp.	.0027	.1052	.2311	.1899	.1230	.2655	.0456	.0227	.0070	.0039	.0017	.0003	.0008	.0005	1.0000	
Numbers	2211	87448	192273	157955	102310	221027	38085	19028	5848	3403	1258	222	695	404		832168
Mean Lnth cm.	43.00	46.40	51.82	57.76	63.06	67.23	74.88	79.90	88.27	95.66	100.00	88.00	93.00	95.50	Mean length in catch	60.10
Mean Wt. kg.	.640	.820	1.157	1.619	2.139	2.632	3.683	4.492	6.099	8.247	8.904	5.920	7.410	7.622	Mean weight in catch	1.997
Biomass (Tonnes)	1.42	71.66	222.24	255.55	218.85	580.38	139.92	85.15	35.74	26.48	12.48	1.31	4.82	3.38	Sample catch	1659.38

Number in this key: 831376
Number in unculled key: 2214051 (37.55% 4VsW by numbers)

Sampled catch in this key: 1659.38
Sampled catch in unculled key: 3272.43 (50.71% 4VsW by weight)

Total landings in unculled key: 15532
Total 4VsW landings in this key: 7876

Table 13. Reconstructed age-length key for 4T cod culled from 4VsW Q1-OTB keys for 1990.

Age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Length Composition	Numbers
25															.0000	0
28	.0005														.0005	664
31															.0000	0
34		.0010													.0010	1328
37		.0024	.0003												.0027	3764
40		.0040	.0066	.0010	.0010										.0125	17270
43			.0332	.0301	.0032	.0016	.0016								.0697	96311
46			.0616	.0539	.0231	.0257	.0154	.0077							.1873	258601
49				.0996	.0353	.0353	.0160	.0289							.2150	296904
52				.0441	.0441	.0353	.0353	.0588	.0029						.2205	304432
55					.0375	.0242	.0242	.0330	.0088						.1278	176460
58						.0306	.0175	.0205	.0029	.0014	.0014				.0744	102732
61							.0109	.0120		.0037					.0266	36753
64							.0152	.0181	.0029						.0362	50038
67								.0091	.0024	.0008					.0123	17048
70								.0085	.0014					.0005	.0104	14391
73									.0013	.0005					.0018	2435
76									.0006		.0003				.0010	1328
79										.0002					.0002	221
82											.0002				.0002	221
85																
Age comp.	.0005	.0074	.1017	.2286	.1441	.1526	.1361	.1967	.0232	.0066	.0019	.0000	.0000	.0005	1.0000	
Numbers	677	10208	140389	315775	199135	210898	188057	271800	32118	9085	2669	0	0	666		1381477
Mean Lnth cm.	28.00	38.27	44.60	48.04	50.81	51.88	54.23	55.58	59.86	62.40	63.07	-	-	70	Mean length in catch	51.33
Mean Wt. kg.	.169	.450	.721	.914	1.090	1.172	1.368	1.480	1.869	2.076	2.248	-	-	2.908	Mean weight in catch	1.16
Biomass (Tonnes)	1.42	71.70	222.40	255.67	218.88	581.69	140.27	85.48	35.67	28.07	11.20	1.31	5.15	3.08	Sampled catch	1603.53

Number in this key: 1381477
Number in unculled key: 2214051 (62.40% 4T by numbers)

Length-weight parameters: a = 0.0054 b = 3.1862

Sampled catch in this key: 1603.53
Sampled catch in unculled key: 3272.43 (49.13% 4T by weight)

Total landings for unculled key: 15532
Total 4T landings for this key: 7627

Table 14. Comparison of 1st quarter and full year catch at age for 4VsW cod before and after culling 4T fish from samples.

Age	Unculled samples		4T culled samples	
	Q1	Full year	Q1	Full year
1	0	0	0	0
2	0	0	0	0
3	14	332	11	329
4	464	2569	415	2520
5	1583	4162	913	3484
6	2252	3763	750	2243
7	1433	2300	486	1342
8	2054	3276	1049	2259
9	1074	1695	181	791
10	1383	1914	90	606
11	183	335	28	178
12	60	139	16	95
13	19	56	6	43
14	1	17	1	17
15	3	15	3	15
16	5	13	2	10

Table 15. 4VsW cod commercial mean weights at age.

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.53	.79	.49	.43	.00	.00	.00	.61	.57	.59	.60
3	.76	1.01	.96	.79	.71	.79	.80	.97	.69	.81	.81
4	1.08	1.15	.94	1.19	.85	1.05	1.11	1.21	.96	1.16	1.12
5	1.45	1.39	1.17	1.74	1.36	1.50	1.72	1.63	1.57	1.60	1.68
6	1.80	1.84	1.64	2.17	1.88	2.26	2.40	2.33	2.30	2.22	2.13
7	2.28	2.29	2.29	2.59	2.34	3.33	3.15	3.39	3.08	3.10	2.96
8	3.50	2.88	2.29	2.47	2.94	4.37	4.48	4.76	3.72	4.26	3.90
9	4.87	4.82	2.64	3.24	3.69	4.85	4.05	5.34	4.90	5.38	5.69
10	5.70	4.56	4.27	3.62	3.72	5.57	5.29	6.19	6.39	6.96	7.02
11	5.70	7.57	3.85	4.87	4.79	7.39	4.73	7.91	7.25	7.42	7.68
12	8.74	11.56	9.48	9.58	5.46	3.38	4.92	8.57	10.11	10.01	9.45
13	6.77	6.31	7.05	.00	8.24	14.23	6.57	9.61	13.95	8.75	12.05
14	5.92	.00	9.06	.00	12.10	11.54	8.85	10.30	10.26	10.53	8.48
15	9.27	14.49	10.98	.00	12.78	22.97	10.52	8.37	11.97	13.97	9.80
16	6.03	8.73	9.61	.00	8.13	15.50	12.27	12.04	12.89	17.80	17.77

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1990(1)
1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
2	.55	.47	.54	.68	.27	.00	.35	.29	.00	.00
3	.77	.78	.74	.71	.68	.48	.63	.77	.78	.79
4	1.04	1.04	1.06	1.03	.95	.93	.97	1.01	.97	1.00
5	1.53	1.53	1.50	1.45	1.26	1.28	1.26	1.28	1.18	1.29
6	2.33	2.13	2.06	1.97	1.65	1.54	1.73	1.56	1.35	1.65
7	2.73	3.09	2.69	2.39	2.38	1.88	1.92	2.19	1.62	1.97
8	3.99	3.55	3.64	3.10	2.74	2.61	2.37	2.21	2.21	2.68
9	5.34	4.38	4.03	3.84	3.67	3.58	2.79	2.50	2.10	2.85
10	6.84	5.79	5.19	5.03	4.99	4.31	3.67	3.93	2.11	3.39
11	8.53	6.84	7.09	6.32	5.30	6.49	4.92	5.10	4.15	6.15
12	8.88	9.16	8.44	6.13	6.87	6.32	7.06	5.16	5.65	7.13
13	10.90	10.64	9.28	9.88	10.18	7.23	7.65	8.55	7.73	9.46
14	10.43	11.73	10.58	11.12	9.57	11.68	11.17	12.28	9.56	9.58
15	13.34	14.07	12.63	11.12	11.89	12.69	12.16	7.87	8.96	9.29
16	14.92	13.55	13.21	14.49	14.52	13.19	14.76	15.38	10.03	12.85

(1) Weights recalculated after culling 4T fish from Q1-OTB key

Table 16. Standardized commercial C/E for mobile gears in 4VsW using NAFO data for 1968-88 and Interzonal data in 1989-90.

MULTIPLE R..... .600 MULTIPLE R SQUARED..... .360

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	1.337E0002	1.337E0002	
REGRESSION	44	3.097E0002	7.039E0000	20.105
Gear	10	1.355E0002	1.355E0001	38.709
Area	1	6.606E0000	6.606E0000	18.869
Month	11	7.880E0001	7.164E0000	20.461
Year	22	1.387E0002	6.306E0000	18.011
RESIDUALS	1571	5.500E0002	3.501E-001	
TOTAL	1616	9.935E0002		

PREDICTED CATCH RATE

STANDARDS USED : Can(M) TC5 OTB2, 4Vs, January

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
68	68279	0.861	1.229	0.141	55562
69	40540	0.854	1.382	0.164	29341
70	48582	0.900	1.370	0.160	35469
71	41495	0.807	0.893	0.100	46461
72	42805	0.803	1.010	0.106	42360
73	41087	0.900	1.027	0.101	39991
74	32848	0.969	0.774	0.073	42451
75	20982	0.935	0.557	0.056	37673
76	15520	0.925	0.739	0.073	20999
77	4597	0.659	0.724	0.082	6345
78	16135	0.300	1.184	0.136	13630
79	28501	0.297	1.507	0.173	18916
80	35244	0.846	1.288	0.119	27359
81	36810	0.863	1.346	0.120	27346
82	38380	0.937	1.664	0.146	23068
83	37853	0.909	1.589	0.142	23827
84	40768	0.931	1.759	0.162	23170
85	41568	0.849	2.165	0.196	19198
86	36979	0.809	2.266	0.207	16322
87	34147	0.798	1.578	0.148	21634
88	27399	0.829	1.451	0.135	18879
89	25605	0.797	1.493	0.142	17155
90	24510	0.759	1.865	0.177	13145

AVERAGE C.V. FOR THE MEAN: .101

Table 16 Continued.

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
Gear	5	INTERCEPT	0.338	0.088	1616
Area	1				
Month	1				
Year	82				
Gear	0	1	-0.057	0.069	131
	1	2	-0.275	0.056	280
	2	3	-0.877	0.073	101
	3	4	-0.403	0.061	168
	4	5	-0.176	0.060	169
	6	6	-0.365	0.083	74
	7	7	-0.068	0.097	47
	8	8	-0.023	0.067	127
	9	9	0.388	0.072	191
	10	10	0.699	0.086	93
Area	2	11	-0.143	0.033	616
Month	2	12	0.124	0.073	161
	3	13	0.026	0.070	204
	4	14	-0.250	0.071	195
	5	15	-0.426	0.073	168
	6	16	-0.557	0.079	120
	7	17	-0.567	0.084	94
	8	18	-0.419	0.081	108
	9	19	-0.403	0.080	113
	10	20	-0.407	0.079	123
	11	21	-0.077	0.079	118
	12	22	-0.058	0.082	100
Year	68	23	-0.300	0.111	45
	69	24	-0.183	0.116	42
	70	25	-0.192	0.114	44
	71	26	-0.620	0.109	48
	72	27	-0.497	0.102	64
	73	28	-0.481	0.095	83
	74	29	-0.765	0.093	83
	75	30	-1.093	0.099	67
	76	31	-0.810	0.095	76
	77	32	-0.829	0.113	38
	78	33	-0.338	0.108	46
	79	34	-0.096	0.106	47
	80	35	-0.255	0.087	83
	81	36	-0.212	0.082	103
	83	37	-0.046	0.084	94
	84	38	0.056	0.086	85
	85	39	0.264	0.086	88
	86	40	0.309	0.086	87
	87	41	-0.052	0.090	77
	88	42	-0.136	0.090	75
	89	43	-0.108	0.093	67
	90	44	0.115	0.093	67

Table 17. 4VsW cod IOP catch rate standardization for trawlers (TC 4-5).

MULTIPLE R..... .655 MULTIPLE R SQUARED..... .429

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.077E0000	2.077E0000	
REGRESSION	20	5.789E0001	2.894E0000	5.794
Year	8	1.189E0001	1.487E0000	2.976
Month	11	4.452E0001	4.047E0000	8.102
TC	1	6.785E-001	6.785E-001	1.358
RESIDUALS	154	7.693E0001	4.996E-001	
TOTAL	175	1.369E0002		

PREDICTED CATCH RATE

STANDARDS USED: January, TC 5

YEAR	TOTAL CATCH	PROP.	CATCH RATE MEAN	S.E.	EFFORT
82	38380	0.109	1.507	0.354	25473
83	37853	0.112	1.377	0.311	27480
84	40768	0.161	2.568	0.585	15878
85	41568	0.140	2.911	0.661	14281
86	36979	0.074	2.529	0.598	14623
87	34107	0.098	2.359	0.553	14459
88	27399	0.172	1.932	0.440	14185
89	25605	0.164	2.633	0.620	9726
90	24510	0.337	1.674	0.382	14640

AVERAGE C.V. FOR THE MEAN: .231

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
Year	82	INTERCEPT	0.187	0.237	175
Month	1				
TC	5				
Year	83	1	-0.092	0.221	23
	84	2	0.531	0.223	22
	85	3	0.657	0.226	21
	86	4	0.518	0.244	16
	87	5	0.448	0.240	17
	88	6	0.247	0.226	21
	89	7	0.558	0.245	16
	90	8	0.104	0.229	20
Month	2	9	0.459	0.236	18
	3	10	0.427	0.236	18
	4	11	-0.437	0.243	16
	5	12	-0.499	0.253	14
	6	13	-0.813	0.259	13
	7	14	-0.892	0.265	12
	8	15	-0.682	0.272	11
	9	16	-0.844	0.265	12
	10	17	-1.092	0.243	16
	11	18	-0.251	0.243	16
	12	19	-0.111	0.274	11
TC	4	20	-0.130	0.111	73

Table 18. 4VsW cod July RV survey mean catch per tow at age.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	.028	.007	.000	.000	.248	.020	.000	.000	.050	.292	.014
1	.424	.441	1.780	1.843	1.484	.949	.675	.213	.875	.348	.198
2	4.732	2.202	2.773	12.585	9.452	2.430	3.703	2.754	3.745	3.042	2.013
3	1.662	10.223	3.405	19.785	5.529	3.763	4.222	6.970	8.956	4.599	5.312
4	2.576	2.301	9.039	16.073	1.616	1.764	2.602	4.527	9.805	4.757	2.941
5	1.277	4.530	1.666	6.444	.578	.858	1.645	2.821	2.712	5.181	4.977
6	.424	1.655	1.717	.535	.642	.188	.321	1.239	1.000	2.595	3.468
7	.500	.992	.465	.833	.107	.230	.154	.267	.255	.773	1.374
8	.159	.423	.157	.258	.133	.061	.258	.177	.053	.289	.373
9	.030	.183	.142	.123	.064	.117	.000	.042	.026	.118	.097
10	.070	.020	.044	.147	.046	.005	.178	.000	.023	.024	.076
11	.080	.039	.000	.048	.018	.000	.024	.028	.000	.013	.027
12	.029	.017	.000	.000	.017	.020	.000	.018	.000	.001	.000
13	.051	.058	.000	.000	.000	.000	.041	.000	.000	.005	.000
14	.000	.000	.000	.058	.000	.000	.000	.000	.000	.000	.000
15	.000	.000	.000	.008	.016	.000	.000	.000	.000	.000	.000
16	.000	.000	.000	.000	.000	.000	.000	.000	.015	.000	.000
0+	12.040	23.090	21.188	58.740	19.951	10.405	13.825	19.054	27.514	22.036	20.869
1+	12.013	23.084	21.188	58.740	19.703	10.385	13.825	19.054	27.464	21.744	20.855
2+	11.589	22.642	19.408	56.897	18.219	9.435	13.150	18.840	26.589	21.397	20.657
3+	6.857	20.441	16.635	44.311	8.767	7.006	9.447	16.087	22.844	18.355	18.644
4+	5.195	10.218	13.229	24.526	3.239	3.243	5.225	9.117	13.888	13.756	13.333

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.024	.003	.020	.070	.000	.027	.044	.069	.029	.003
1	1.328	.733	13.721	.406	1.287	.357	.645	.059	.246	.128
2	3.653	62.940	13.307	7.272	1.683	1.325	1.506	4.703	8.860	5.063
3	5.531	52.596	44.468	12.817	7.881	1.532	4.974	7.291	7.384	18.222
4	8.444	18.371	19.253	19.094	9.564	6.164	4.826	5.895	5.012	8.636
5	3.217	4.125	9.884	12.938	9.319	3.886	8.858	3.267	3.473	3.827
6	2.309	2.228	4.423	6.005	5.117	3.256	3.608	3.412	1.350	1.408
7	1.186	1.201	.988	4.128	2.561	1.146	2.712	1.953	2.000	.601
8	.437	.512	.551	.407	1.008	.548	1.474	.976	.474	.288
9	.144	.114	.140	.332	.484	.241	.341	.218	.324	.106
10	.162	.116	.076	.099	.115	.154	.024	.052	.013	.071
11	.042	.063	.039	.234	.111	.035	.080	.116	.003	.000
12	.007	.000	.018	.006	.068	.000	.043	.016	.019	.000
13	.007	.000	.018	.006	.000	.023	.009	.000	.008	.000
14	.000	.005	.000	.009	.000	.000	.000	.018	.000	.000
15	.007	.000	.000	.000	.013	.000	.026	.000	.000	.000
16	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
0+	26.497	143.007	106.906	63.824	39.211	18.694	29.170	28.043	29.194	38.352
1+	26.473	143.004	106.886	63.754	39.211	18.667	29.126	27.975	29.166	38.350
2+	25.145	142.271	93.165	63.349	37.924	18.310	28.481	27.916	28.920	38.222
3+	21.493	79.331	79.858	56.076	36.241	16.985	26.975	23.213	20.059	33.159
4+	15.962	26.735	35.390	43.259	28.360	15.453	22.001	15.923	12.676	14.937

Table 19. 4VsW cod July RV survey coefficients of variation.

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
0	.514	1.000	.000	.000	.000	1.000	.000	.000	.471	.552	.644
1	.277	.363	.747	.649	.135	.341	.370	.276	.147	.226	.292
2	.063	.303	.295	.771	.032	.266	.165	.174	.425	.257	.397
3	.210	.589	.661	.622	.073	.347	.119	.197	.396	.260	.368
4	.097	.466	.844	.785	.080	.253	.252	.247	.230	.220	.243
5	.078	.582	.677	.708	.313	.187	.227	.397	.292	.191	.233
6	.105	.549	.820	.775	.384	.236	.216	.504	.172	.164	.266
7	.251	.520	.806	.679	.269	.333	.198	.514	.097	.169	.256
8	.291	.344	.624	.327	.457	.402	.000	.492	.318	.177	.339
9	.760	.695	.633	.784	.355	.464	.000	.421	.263	.187	.484
10	.536	.730	.781	.523	.190	1.000	.000	.000	.670	.522	.611
11	.000	.600	.000	.443	1.000	.000	1.000	.471	.000	.404	.688
12	1.000	1.000	.000	.000	.000	1.000	.000	.541	.000	1.000	.000
13	.000	.723	.000	.000	.000	.000	.000	.000	.000	.885	.000
14	.000	.000	.000	.676	.000	.000	.000	.000	.000	.000	.000
15	.000	.000	.000	.713	1.000	.000	.000	.000	.000	.000	.000
16	.000	.000	.000	.000	.000	.000	.000	.000	1.000	.000	.000

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	.760	1.000	1.000	.534	.000	.698	1.000	.588	1.000	1.000
1	.395	.299	.905	.563	.667	.368	.346	.449	.226	.548
2	.316	.854	.395	.285	.326	.490	.293	.458	.620	.514
3	.385	.822	.501	.566	.175	.286	.376	.509	.485	.373
4	.293	.744	.424	.478	.262	.341	.274	.319	.325	.298
5	.256	.362	.390	.491	.341	.347	.240	.307	.241	.346
6	.224	.076	.221	.481	.337	.312	.286	.483	.233	.307
7	.269	.046	.135	.540	.263	.290	.304	.444	.267	.301
8	.271	.025	.184	.357	.214	.286	.281	.393	.250	.308
9	.450	.097	.214	.526	.198	.300	.257	.268	.285	.388
10	.518	.000	.000	.311	.242	.291	.394	.347	.676	.351
11	.662	.000	.000	.713	.469	.542	.395	.358	1.000	.000
12	1.000	.000	.000	1.000	.290	.000	.531	.425	.631	.000
13	1.000	.000	.000	.740	.000	1.000	1.000	.000	.733	.000
14	.000	.000	.000	.736	.000	.000	.000	.638	.000	.000
15	1.000	.000	.000	.000	1.000	.000	.585	.000	.000	.000
16	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Table 20. 4VsW cod Spring RV mean catch per tow at age.

	1979	1980	1981	1982	1983	1984	1985	1986
0	.000	.000	.000	.000	.000	.000	.000	.000
1	.260	.863	8.249	2.646	.851	.217	.000	.188
2	2.123	2.709	3.801	22.224	3.169	1.490	.000	10.877
3	.892	2.042	5.293	17.907	42.138	1.846	.000	19.439
4	.597	1.665	7.787	11.836	25.520	9.367	.000	23.579
5	1.372	2.518	4.869	7.241	4.960	6.212	.000	11.666
6	1.020	2.900	5.765	1.989	5.846	2.918	.000	13.128
7	.473	1.426	3.205	1.363	1.316	2.535	.000	6.272
8	.286	.304	1.532	1.082	.618	.774	.000	1.337
9	.065	.064	.177	.280	.289	.504	.000	.735
10	.099	.025	.135	.143	.096	.195	.000	.279
11	.077	.015	.027	.063	.037	.017	.000	.044
12	.022	.002	.023	.031	.043	.086	.000	.050
13	.027	.009	.000	.011	.015	.000	.000	.007
14	.009	.005	.000	.000	.045	.006	.000	.007
15	.010	.000	.000	.005	.000	.000	.000	.000
16	.000	.000	.000	.007	.000	.021	.000	.008
1+	7.332	14.548	40.864	66.828	84.941	26.188	.000	87.616
2+	7.072	13.685	32.615	64.182	84.089	25.970	.000	87.428
3+	4.949	10.975	28.814	41.957	80.920	24.480	.000	76.552
4+	4.057	8.934	23.521	24.051	38.783	22.634	.000	57.113

	1987	1988	1989	1990	1991
0	.000	.000	.000	.000	.000
1	.346	.601	.578	.124	.022
2	.919	7.965	17.957	1.603	3.500
3	2.874	9.490	10.396	5.075	12.148
4	4.496	4.262	4.228	2.562	21.917
5	10.138	4.325	4.796	.864	5.091
6	4.818	4.880	1.680	.308	1.490
7	3.324	1.434	.704	.193	.348
8	1.204	1.870	.224	.362	.023
9	.237	.463	.255	.128	.099
10	.105	.186	.048	.123	.003
11	.036	.178	.027	.037	.014
12	.029	.041	.017	.025	.003
13	.029	.024	.003	.012	.020
14	.010	.000	.010	.000	.006
15	.000	.033	.020	.000	.000
16	.000	.000	.000	.000	.000
1+	28.564	35.750	40.945	11.418	44.685
2+	28.218	35.149	40.367	11.294	44.663
3+	27.299	27.185	22.409	9.691	41.164
4+	24.425	17.695	12.014	4.616	29.016

Table 21. 4VsW cod Spring RV survey coefficients of variation.

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1	.287	.306	.000	.000	.402	.208	.000	.000	.201	.153	.582	.375	.543
2	.142	.457	.528	.000	.580	.166	.000	.000	.081	.700	.758	.408	.672
3	.181	.400	.200	.000	.709	.140	.000	.000	.038	.804	.489	.444	.915
4	.250	.307	.198	.000	.516	.259	.000	.000	.011	.508	.484	.471	.888
5	.174	.376	.266	.000	.368	.389	.000	.000	.011	.541	.440	.340	.740
6	.166	.485	.245	.000	.309	.455	.000	.000	.018	.434	.380	.314	.573
7	.383	.550	.192	.000	.297	.380	.000	.000	.104	.368	.338	.334	.519
8	.309	.639	.223	.000	.296	.370	.000	.000	.129	.392	.578	.647	.453
9	.088	.343	.174	.000	.364	.549	.000	.000	.172	.434	.381	.468	.483
10	.274	.769	.333	.000	.641	.400	.000	.000	.094	.355	.293	.516	1.000
11	.275	.401	.630	.000	.888	.527	.000	.000	.000	.050	.438	.526	.407
12	.211	1.000	.455	.000	.492	.315	.000	.000	.000	.426	.651	.000	1.000
13	.702	.826	.000	.000	.768	.000	.000	.000	.000	.000	1.000	.407	.597
14	.000	1.000	.000	.000	.564	1.000	.000	.000	.000	.000	.857	.000	.029
15	.000	.000	.000	.000	.000	.000	.000	.000	.000	.273	.857	.000	.000
16	.000	.000	.000	.000	.000	1.000	.000	.000	.000	.000	.000	.000	.000

Table 22. Summary of ADAPT Formulations.

	Mean fully recruited F	Age 1 Numbers 86 y.c.	87 y.c.
1. Half year SPA * - no cull of 4T.	0.91	49890	149236
2. Full year SPA - no cull of 4T.	1.17	49872	39294
3. Half year SPA - 4T culled in Q1.	0.56	48603	177004
4. Full year SPA - 4T culled in Q1.	0.59	48905	76998
5. Half year SPA - 4T culled in Q1, age 3 estimated.	0.50	65670	94256
6. Full year SPA - 4T culled in Q1, age 3 estimated.	0.53	65891	94161

* - same as last assessment.

Table 23. ADAPT (3 INDEX) TUNING MAY 1991 - 4VsW COD

POPULATION NUMBERS (000S)

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	85607	67144	61957	75861	84586	72028	67612	105014	93677	109311	123265
2	68865	68294	53121	49624	60958	67861	58507	55355	86193	76685	89469
3	57857	44778	41559	34244	34004	42153	52967	47881	45236	70485	62701
4	25391	38644	25983	26786	15980	21143	31924	42884	38145	35442	56111
5	25946	16151	20791	16022	11349	10221	13051	25025	31421	25295	24608
6	20390	15260	6542	8305	6916	4959	4840	9246	16130	17107	14433
7	10173	12054	6588	2349	4766	2679	2174	3198	5234	8631	8416
8	3623	5236	6876	2345	1318	1239	1029	1336	1924	3190	4307
9	2477	1190	2585	1348	1008	515	610	662	871	1234	1597
10	619	1391	661	593	926	375	299	393	446	644	727
11	249	175	717	189	347	138	259	215	254	344	444
12	347	60	82	89	143	129	102	174	148	199	236
13	202	128	42	60	71	6	63	43	118	117	139
14	205	24	72	15	49	21	5	41	10	94	92
15	73	96	20	40	12	35	13	1	25	8	77
16	136	23	76	0	33	5	28	9	0	20	6
1+	302162	270648	227672	217869	222466	223506	233483	291779	319830	348808	386630

	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	72785	71879	34504	34612	45651	65891	94161	0	0
2	100918	59588	58849	28250	28338	37376	53947	77093	0
3	73017	82500	48781	48181	23125	23199	30601	44161	63112
4	48440	57544	64372	39550	39306	18821	18959	24887	35549
5	37673	32722	39260	47475	30342	28372	14616	14154	18074
6	13559	21685	20019	23908	31494	17929	18077	9796	7869
7	7608	7771	12073	11252	12767	17442	9354	10700	5003
8	4215	3906	4638	6420	5336	7206	8807	3971	5441
9	2241	2261	2282	2667	3058	2947	3426	4229	1626
10	949	1220	1286	1376	1221	1487	1413	1239	1636
11	473	489	796	790	718	595	671	591	481
12	301	249	266	513	390	330	277	314	257
13	165	188	157	160	264	224	151	88	116
14	94	86	132	98	70	156	129	66	46
15	74	27	57	93	62	47	118	97	41
16	59	43	17	39	60	33	26	88	27
1+	362571	342157	287489	245385	222203	222056	254733	191473	139276

Table 23 (continued). ADAPT (3 INDEX) TUNING MAY 1991 - 4VsW COD

FISHING MORTALITY

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	.026	.034	.022	.019	.020	.008	.000	.000	.000	.000	.000	.000	.000
2	.230	.297	.239	.178	.169	.048	.000	.002	.001	.001	.003	.002	.000
3	.204	.344	.239	.562	.275	.078	.011	.027	.044	.028	.058	.038	.048
4	.252	.420	.283	.659	.247	.282	.043	.111	.211	.165	.198	.192	.182
5	.331	.704	.718	.640	.628	.548	.145	.239	.408	.361	.396	.352	.291
6	.326	.640	.824	.355	.748	.625	.214	.369	.425	.509	.440	.357	.386
7	.464	.361	.833	.378	1.147	.757	.287	.308	.295	.495	.491	.467	.316
8	.913	.506	1.430	.645	.739	.509	.240	.229	.244	.492	.454	.423	.337
9	.377	.389	1.272	.175	.788	.345	.240	.197	.101	.329	.321	.408	.365
10	1.064	.462	1.052	.336	1.707	.170	.130	.237	.059	.172	.230	.463	.227
11	1.227	.561	1.890	.079	.793	.101	.197	.174	.045	.175	.188	.442	.411
12	.799	.160	.114	.025	3.022	.518	.650	.188	.030	.156	.162	.273	.262
13	1.918	.372	.815	.000	1.020	.000	.215	1.243	.028	.038	.192	.450	.152
14	.563	.000	.388	.000	.146	.238	1.240	.311	.000	.000	.024	1.040	.214
15	.938	.035	99.990	.000	.770	.000	.179	99.990	.000	.141	.074	.335	.279
16	.551	.404	1.159	99.990	1.020	.640	.267	.273	99.990	.479	.461	.444	.330
1+	.551	.404	1.159	.436	1.020	.640	.267	.273	.262	.479	.461	.444	.330

	1984	1985	1986	1987	1988	1989	1990
1	.000	.000	.000	.000	.000	99.990	99.990
2	.000	.000	.000	.000	.000	.000	99.990
3	.010	.004	.006	.002	.007	.017	.006
4	.104	.065	.126	.053	.092	.120	.082
5	.296	.210	.326	.251	.200	.387	.240
6	.376	.427	.391	.451	.324	.472	.378
7	.432	.546	.372	.483	.657	.476	.352
8	.354	.542	.394	.543	.534	.693	.614
9	.306	.581	.521	.535	.817	.749	.771
10	.287	.451	.518	.596	.672	.747	.526
11	.239	.506	.578	.566	.559	.634	.526
12	.304	.466	.353	.578	.944	.796	.526
13	.274	.632	.324	.357	.630	.452	.526
14	.154	.257	.191	.081	.081	.289	.526
15	.169	.227	.415	.398	.098	1.080	.526
16	.397	.549	.399	.505	.632	.583	.526
1+	.397	.549	.399	.505	.632	.583	.526

Table 23 (continued). ADAPT (3 INDEX) TUNING MAY 1991 - 4VsW COD

MEAN SQUARE RESIDUALS : 0.4271814099
MEAN RESIDUAL : -5.883669677E-4
SUM OF ALL RESIDUALS : -0.1259105311

LOG RESIDUALS FROM JULY RV INDEX

	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
3	.087	-.674	1.099	.206	-.340	-.554	-.320	.041	-.559	-.868	-.693	1.395
4	-.696	.350	1.243	-.865	-.502	-.372	-.370	.147	-.401	-.835	-.220	.701
5	-.051	-.359	.749	-1.446	-.714	-.005	.054	-.581	-.063	.087	-.302	-.505
6	-.643	-.134	-.345	-.674	-1.491	-.695	.440	-.331	.099	.379	.102	.080
7	-.194	-1.181	.281	-1.009	-.498	-.552	-.068	-.486	.123	.315	.190	.289
8	.429	-1.168	-.402	-.451	-.603	.775	.427	-1.049	.293	.187	.022	.185
9	-.146	.339	-.061	-.700	.548	3.104	-.308	-.891	.298	-.114	.020	-.498

	1983	1984	1985	1986	1987	1988	1989	1990
3	1.111	.370	-.107	-1.010	.162	.271	-.078	.462
4	.570	.404	.177	-.221	.229	.444	.026	.191
5	.475	.564	-.004	-.363	.484	.120	.322	.089
6	.313	.693	.386	-.363	.338	.200	-.028	.178
7	-.014	1.042	.702	-.330	.284	.680	.464	-.050
8	.284	-.181	.510	-.001	.776	.157	.325	-.534
9	-.332	.491	.872	.003	.394	-.037	.108	-.038

SUM OF RV RESIDUALS : -0.08976971828 MEAN RESIDUAL : -6.552534181E-4

LOG RESIDUALS FROM MARCH RV INDEX

	1979	1980	1981	1982	1983	1984	1986	1987	1988	1989	1990
3	-1.859	-1.478	-.401	.661	1.397	-1.215	1.885	-.031	.888	.615	-.462
4	-2.214	-1.126	-.035	.529	1.123	-.011	1.411	.472	.421	.148	-.719
5	-1.312	-.500	.196	.156	-.097	-.053	.843	.750	.549	.731	-1.264
6	-1.020	-.013	.827	-.195	.420	-.197	.857	.433	.406	-.010	-1.510
7	-.581	.072	.906	.146	.051	.295	1.131	.212	.037	-.853	-1.418
8	-.089	-.472	.835	.501	-.004	.054	.470	.102	.339	-.945	-.800
9	-.443	-.752	.007	.147	.158	.690	.829	-.263	.327	-.497	-.224

SUM OF RV RESIDUALS : -0.03614081282 MEAN RESIDUAL : -4.693612054E-4

Table 23 (continued). ADAPT (3 INDEX) TUNING MAY 1991 - 4VsW COD

ESTIMATED PARAMETERS AND STANDARD ERRORS
APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET..... 0.008330
MEAN SQUARE RESIDUALS 0.427181

PARAMETER	AGE	ESTIMATE	STD. ERR.	T-STAT	C.V.
NUMBERS					
	3	63112	30373	2.078	0.481
	4	35549	12228	2.907	0.344
	5	18074	5453	3.314	0.302
	6	7869	2548	3.088	0.324
	7	5003	1658	3.018	0.331
	8	5441	1920	2.834	0.353
	9	1626	674	2.412	0.415
JULY RV					
	3	2.05E-004	3.10E-005	6.606	0.151
	4	2.37E-004	3.53E-005	6.707	0.149
	5	2.50E-004	3.81E-005	6.571	0.152
	6	2.10E-004	3.19E-005	6.571	0.152
	7	1.74E-004	2.59E-005	6.736	0.148
	8	1.45E-004	2.16E-005	6.720	0.149
	9	1.20E-004	1.83E-005	6.543	0.153
MARCH RV					
	3	1.34E-004	2.81E-005	4.783	0.209
	4	1.59E-004	3.24E-005	4.900	0.204
	5	1.89E-004	3.81E-005	4.954	0.202
	6	2.05E-004	4.14E-005	4.953	0.202
	7	1.83E-004	3.70E-005	4.941	0.202
	8	1.82E-004	3.69E-005	4.919	0.203
	9	1.26E-004	2.55E-005	4.916	0.203

Table 23 (continued). ADAPT (3 INDEX) TUNING MAY 1991 - 4VsW COD

Parameter Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000	.060	.050	.040	.037	.018	.014	-.176	-.017	-.012	-.009	-.007	-.005
2	.060	1.000	.069	.055	.051	.032	.016	-.136	-.130	-.017	-.013	-.010	-.008
3	.050	.069	1.000	.067	.061	.042	.021	-.114	-.108	-.116	-.016	-.013	-.010
4	.040	.055	.067	1.000	.073	.055	.028	-.092	-.087	-.092	-.123	-.016	-.013
5	.037	.051	.061	.073	1.000	.053	.045	-.084	-.081	-.083	-.096	-.136	-.039
6	.018	.032	.042	.055	.053	1.000	.067	-.064	-.063	-.069	-.084	-.108	-.165
7	.014	.016	.021	.028	.045	.067	1.000	-.033	-.032	-.034	-.043	-.059	-.098
8	-.176	-.136	-.114	-.092	-.084	-.064	-.033	1.000	.041	.029	.023	.019	.015
9	-.017	-.130	-.108	-.087	-.081	-.063	-.032	.041	1.000	.028	.022	.018	.015
10	-.012	-.017	-.116	-.092	-.083	-.069	-.034	.029	.028	1.000	.023	.019	.016
11	-.009	-.013	-.016	-.123	-.096	-.084	-.043	.023	.022	.023	1.000	.023	.019
12	-.007	-.010	-.013	-.016	-.136	-.108	-.059	.019	.018	.019	.023	1.000	.026
13	-.005	-.008	-.010	-.013	-.039	-.165	-.098	.015	.015	.016	.019	.026	1.000
14	-.005	-.007	-.009	-.011	-.055	-.079	-.177	.013	.013	.014	.017	.023	.029
15	-.231	-.177	-.148	-.118	-.108	-.036	-.040	.086	.051	.035	.026	.019	.012
16	-.023	-.172	-.143	-.115	-.106	-.082	-.021	.054	.051	.036	.028	.023	.017
17	-.015	-.021	-.151	-.118	-.103	-.082	-.040	.037	.035	.037	.029	.023	.019
18	-.012	-.017	-.021	-.159	-.122	-.105	-.053	.029	.028	.030	.037	.028	.024
19	-.009	-.013	-.017	-.021	-.177	-.139	-.076	.024	.023	.025	.029	.040	.033
20	-.006	-.010	-.013	-.017	-.048	-.215	-.128	.020	.019	.021	.025	.033	.046
21	-.006	-.009	-.011	-.014	-.069	-.098	-.227	.017	.016	.017	.021	.029	.037

	14	15	16	17	18	19	20	21
1	-.005	-.231	-.023	-.015	-.012	-.009	-.006	-.006
2	-.007	-.177	-.172	-.021	-.017	-.013	-.010	-.009
3	-.009	-.148	-.143	-.151	-.021	-.017	-.013	-.011
4	-.011	-.118	-.115	-.118	-.159	-.021	-.017	-.014
5	-.055	-.108	-.106	-.103	-.122	-.177	-.048	-.069
6	-.079	-.036	-.082	-.082	-.105	-.139	-.215	-.098
7	-.177	-.040	-.021	-.040	-.053	-.076	-.128	-.227
8	.013	.086	.054	.037	.029	.024	.020	.017
9	.013	.051	.051	.035	.028	.023	.019	.016
10	.014	.035	.036	.037	.030	.025	.021	.017
11	.017	.026	.028	.029	.037	.029	.025	.021
12	.023	.019	.023	.023	.028	.040	.033	.029
13	.029	.012	.017	.019	.024	.033	.046	.037
14	1.000	.014	.014	.017	.021	.030	.038	.048
15	.014	1.000	.066	.044	.033	.025	.015	.017
16	.014	.066	1.000	.045	.036	.029	.023	.017
17	.017	.044	.045	1.000	.037	.030	.025	.021
18	.021	.033	.036	.037	1.000	.037	.032	.027
19	.030	.025	.029	.030	.037	1.000	.043	.038
20	.038	.015	.023	.025	.032	.043	1.000	.048
21	.048	.017	.017	.021	.027	.038	.048	1.000

Figure 1. Nominal catch and TAC for 4VsW cod.

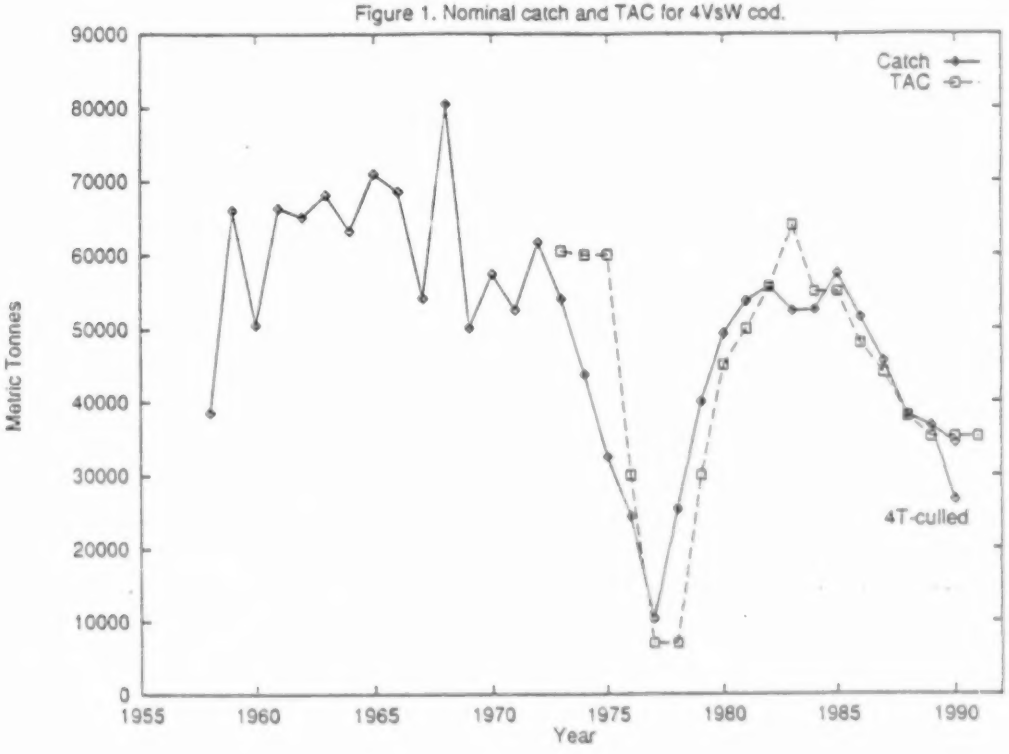

Figure 2. Percent of 4VsW cod catch taken in Subdiv. 4Vs

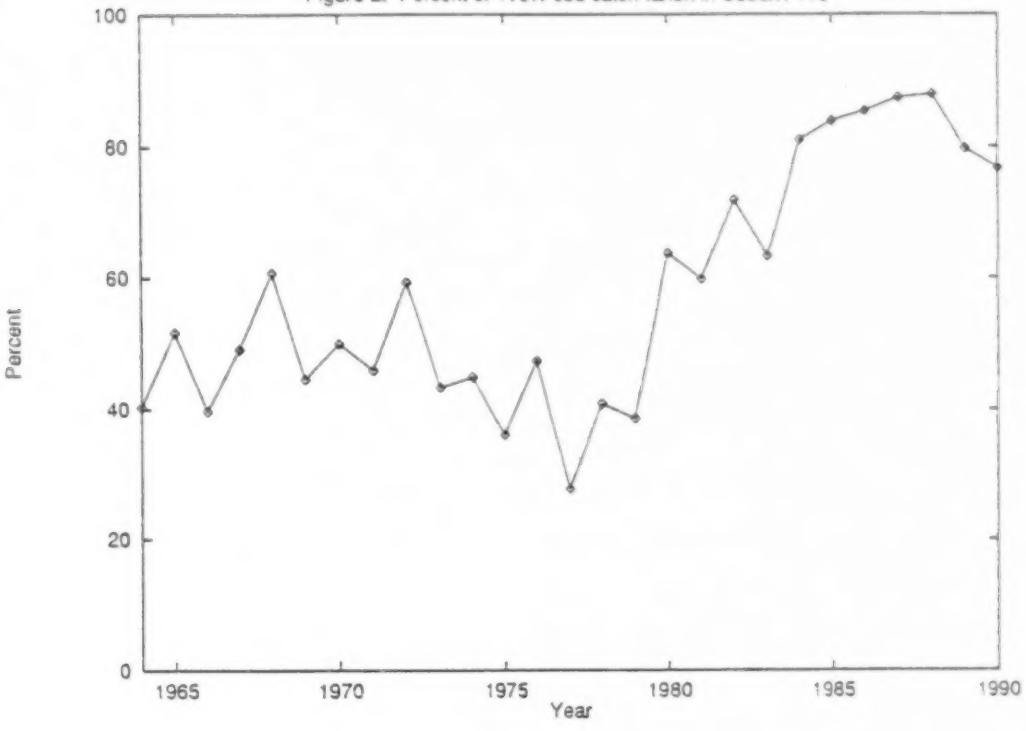

Figure 3. Catches of 4VsW cod by gear sectors.

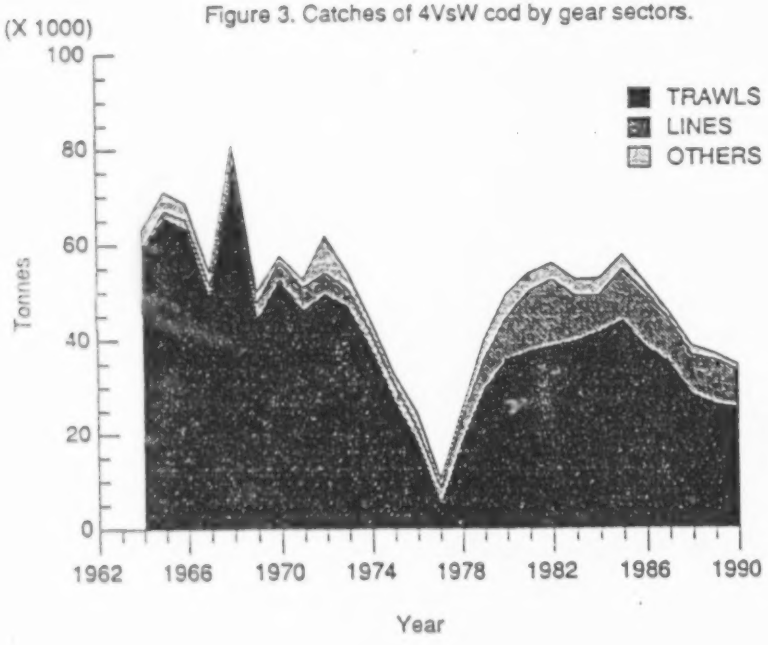

Figure 4. Comparison of observed and projected catch at age in 4VsW cod for 1990

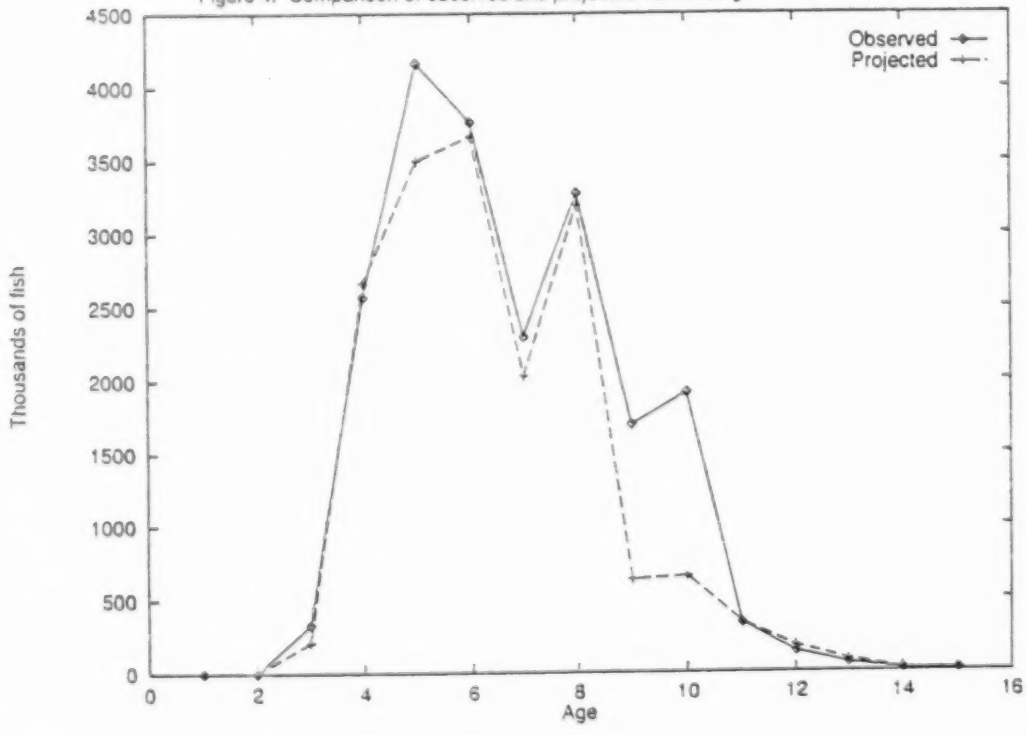

Figure 5. Proportion of total 4VsW catch taken in 4Vs by OTB's in the first quarter.

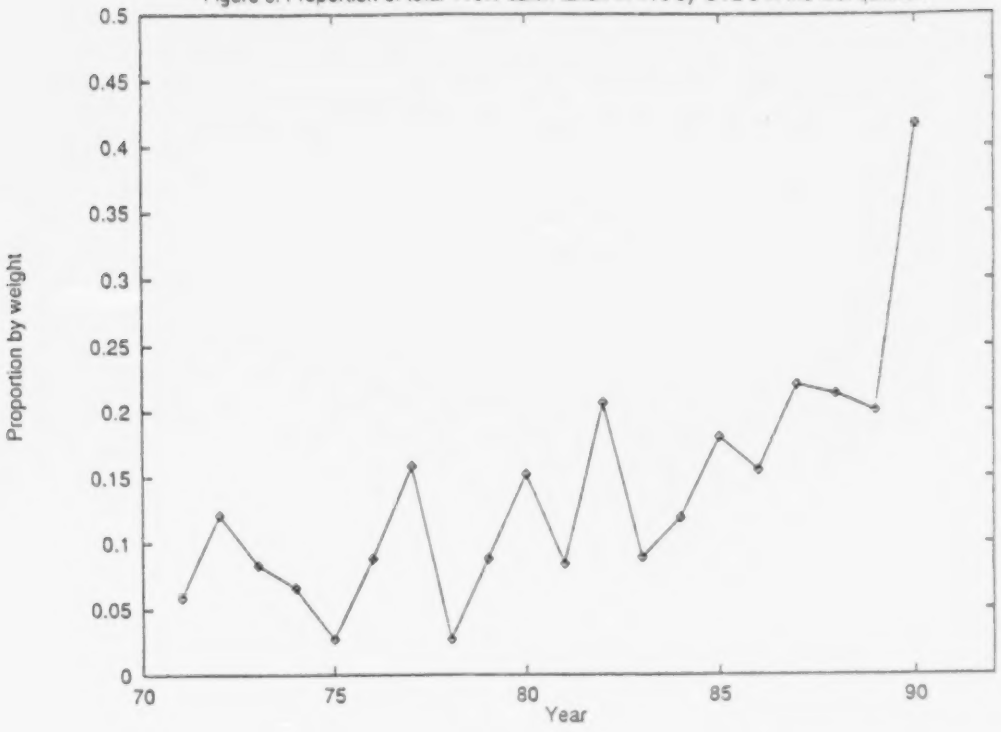

Figure 6. Total observed (IOP) catches of cod in 4V for the 1st quarter aggregated by 10' squares.

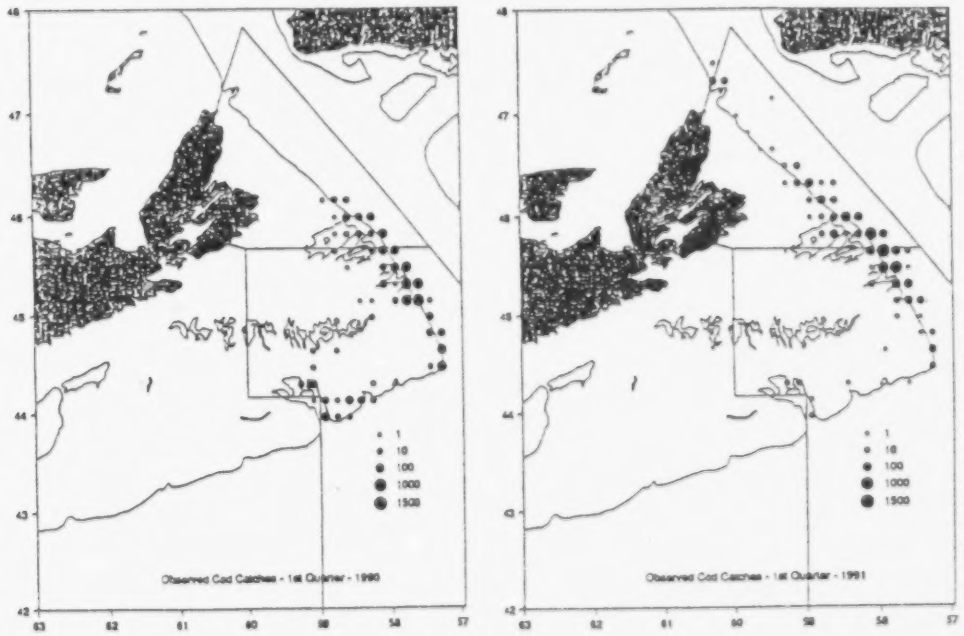

Figure 7. Comparison of original and 4T-culled catch at age for 4VsW cod in 1990

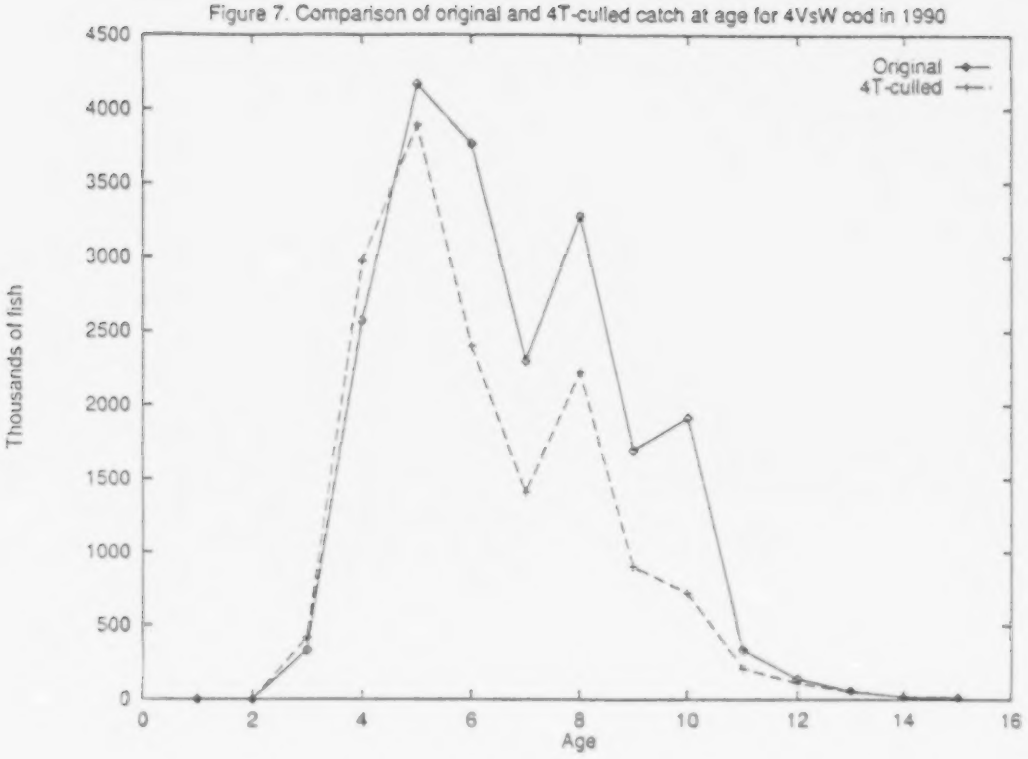

Figure 8. Standardized 4VsW cod trawler catch rates.

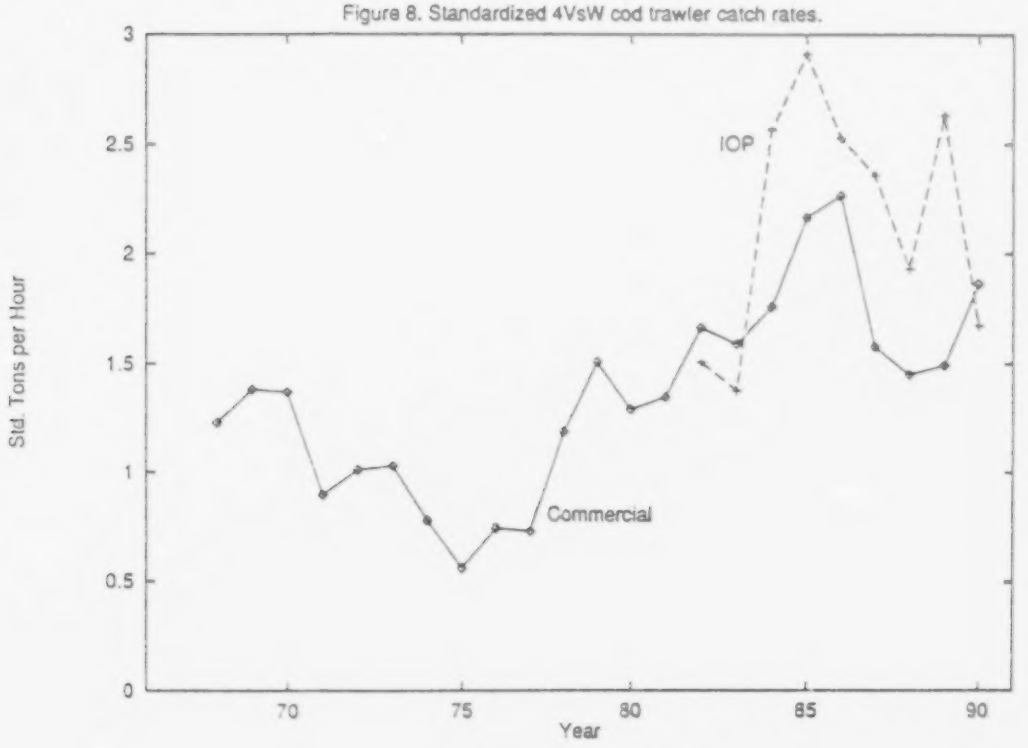

Figure 9. RV survey mean catch per tow for 4VsW cod (all ages).

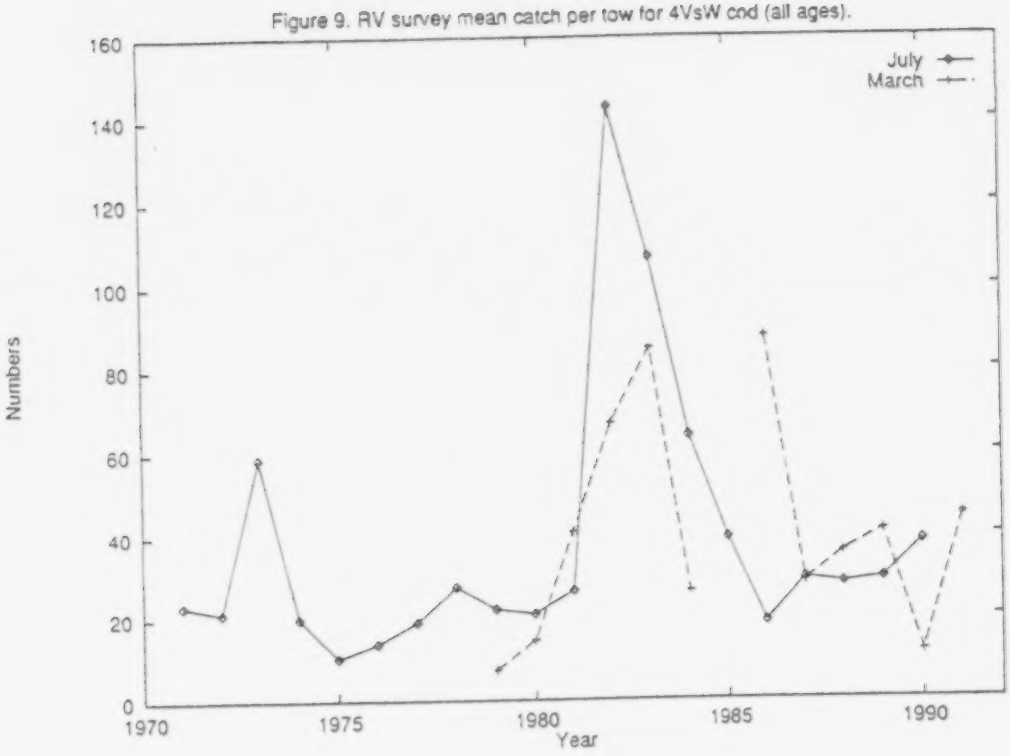

Figure 10. RV survey mean catch per tow for 4VsW cod (ages 4+).

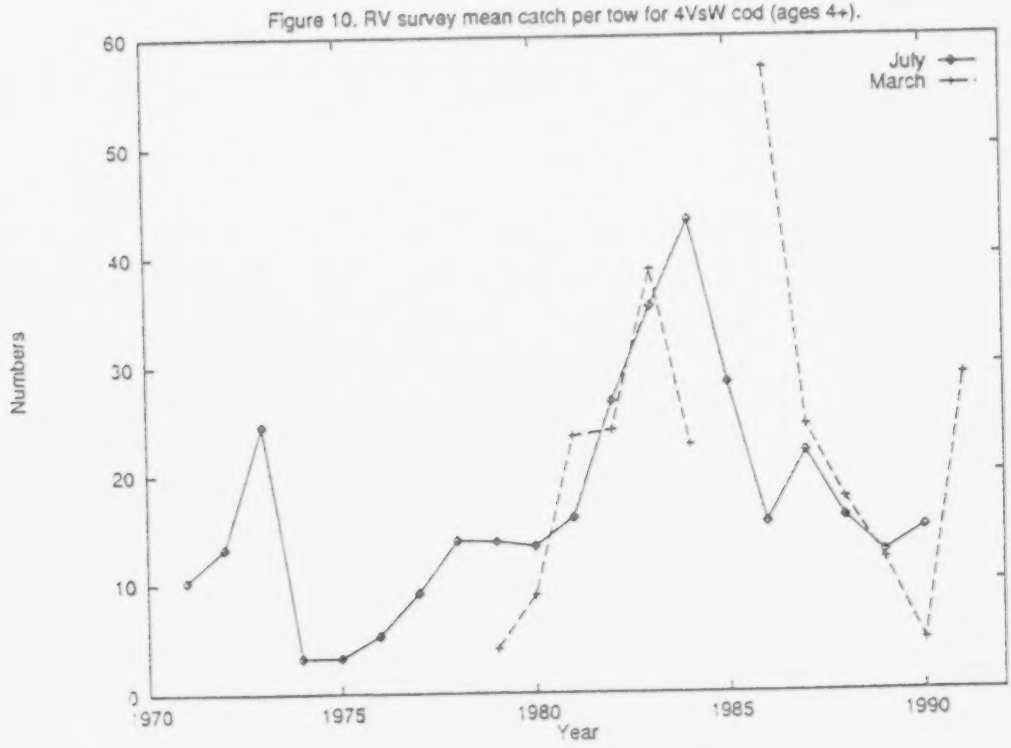

Figure 11. Fully recruited fishing mortality in 4VsW cod.

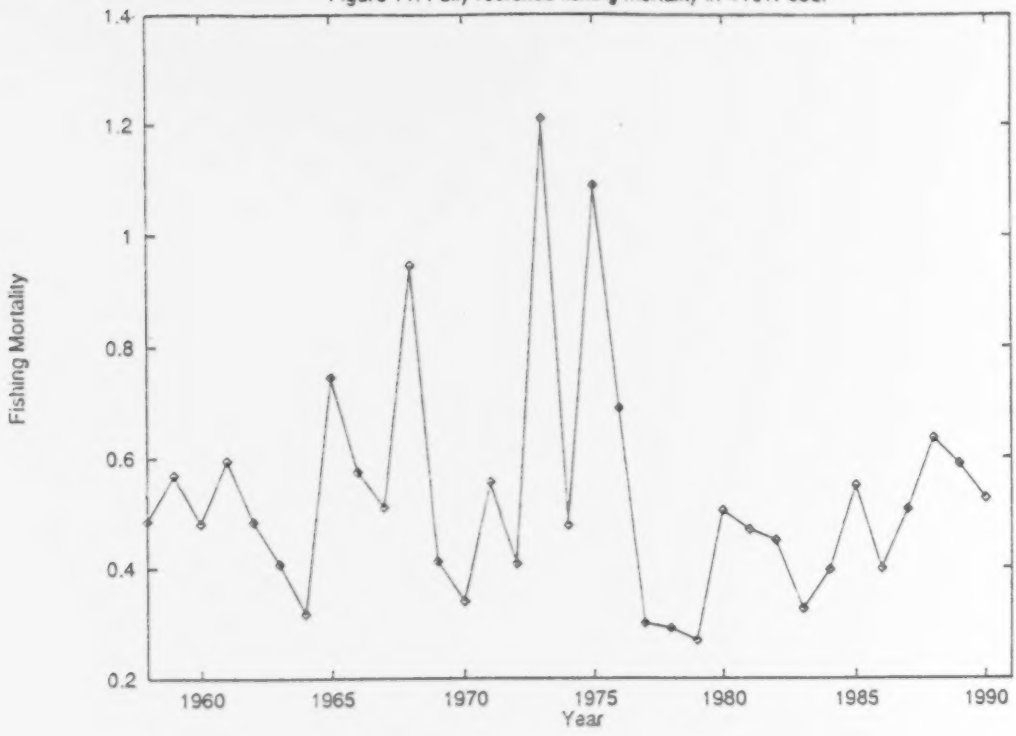

Figure 12. Population numbers and biomass for ages 3+ in 4VsW cod.

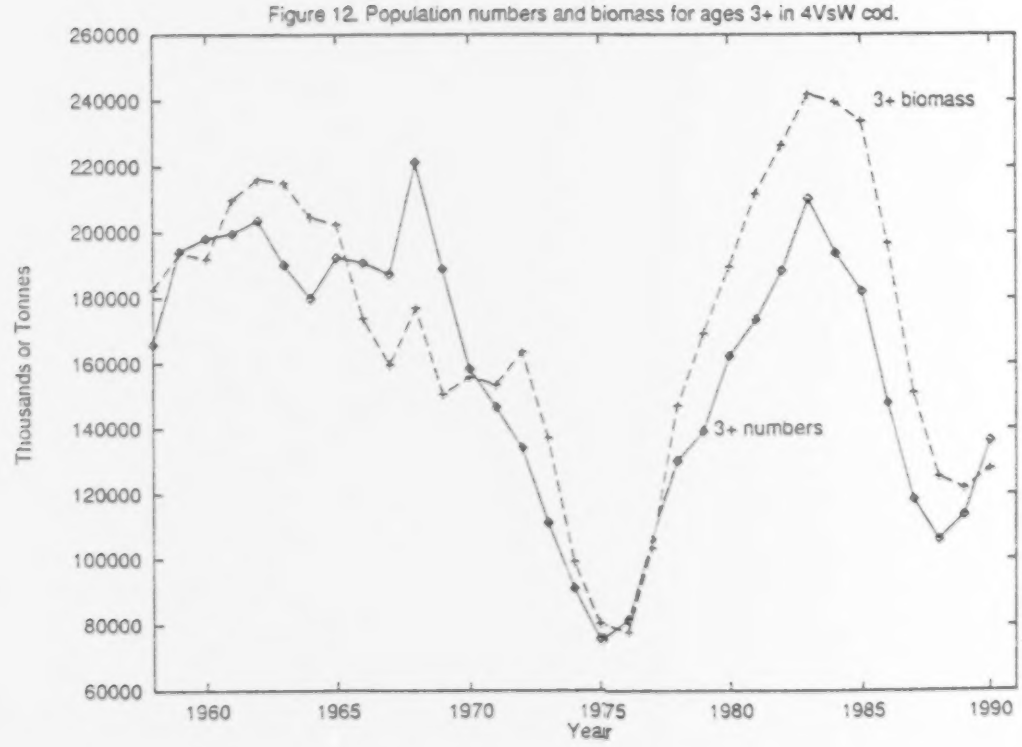

Figure 13. Age 1 recruitment in 4VsW cod.

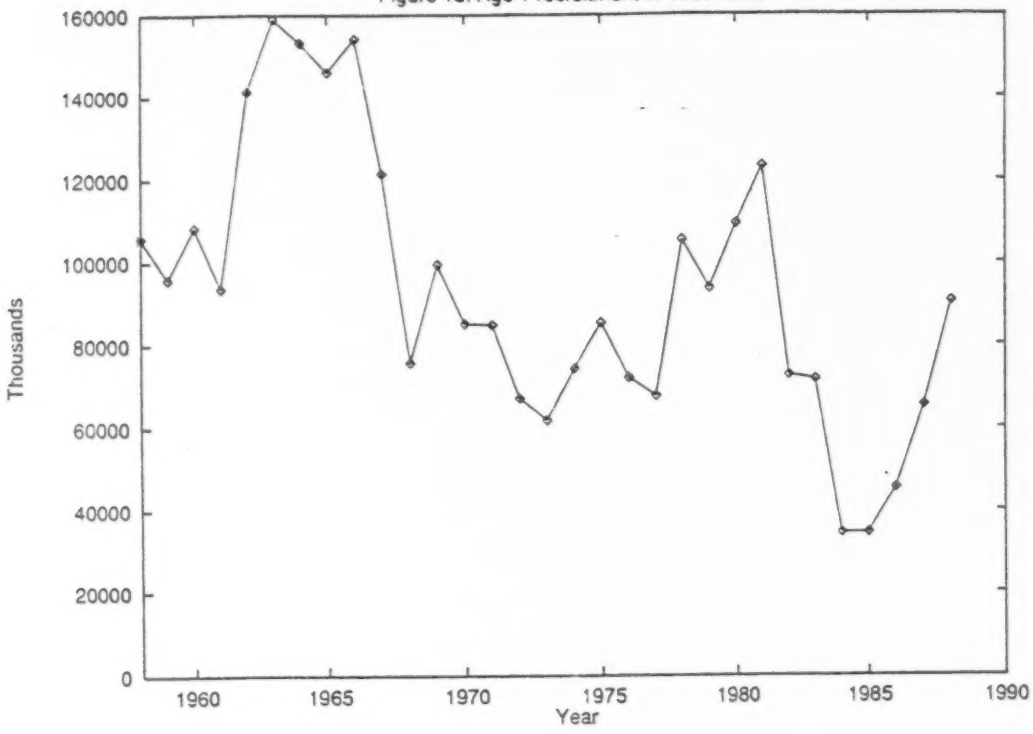

Figure 14. Retrospective fishing mortality in 4VsW cod.